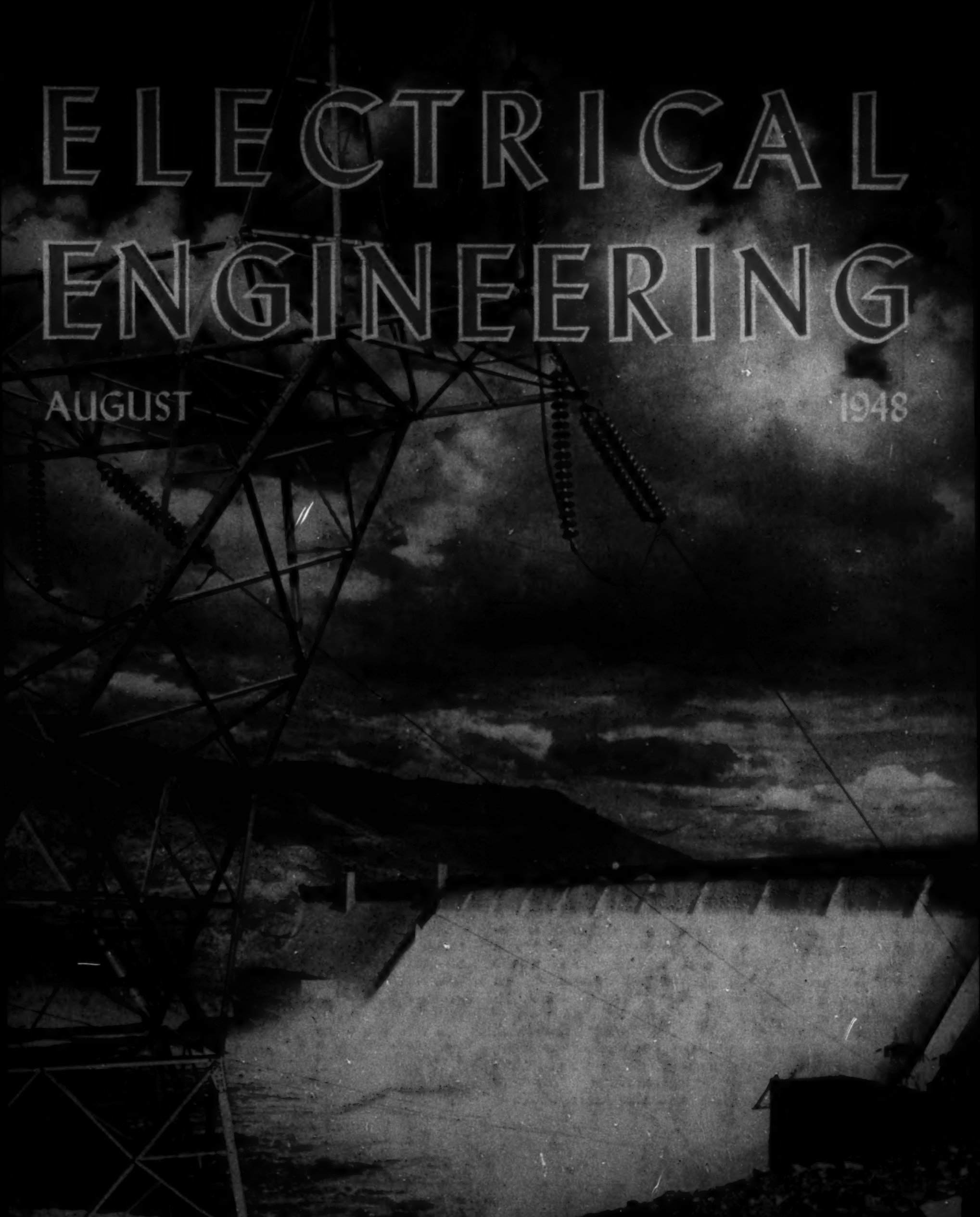
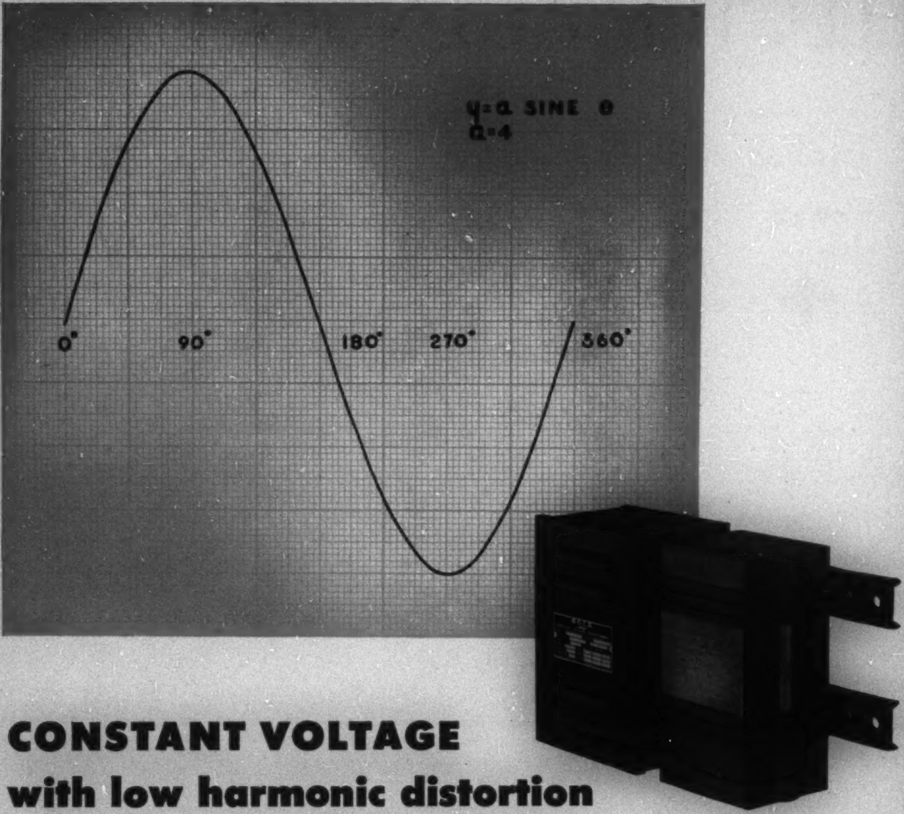
ELECTRICAL ENGINEERING

AUGUST 1948



AIEE PACIFIC GENERAL MEETING, SPOKANE, WASH., AUGUST 24–27, 1948



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AUGUST

1948

The Cover: Grand Coulee Dam in Washington which develops 1,300,000 horsepower for the West Coast, eventually will produce more than 3 million horsepower. Various interesting developments in Grand Coulee's history provide subject matter for a number of papers scheduled for presentation at the AIEE Pacific general meeting in Spokane Wash., August 24–27, 1948.
Allis-Chalmers photo

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HIGHLIGHTS........

"Our Institute." As the Institute advances into the 65th year of its history, the incoming president of AIEE, Everett S. Lee of the General Electric Company, Schenectady, N. Y., reviews the contributions of the electrical engineer to modern American life—and reminds us that the story of service that the engineer has written is the story of the Institute (*page 777*).

"Institute Problems." Past-President Blake D. Hull, outgoing president of AIEE, discusses the functions and organization of the Institute on the basis of his observations during his term of presidency, giving credit where credit is due, and making some pertinent suggestions for improvement (*page 776*).

Summer General Meeting. According to the verified registration figures, a total of 1,047 members and guests were attracted to Mexico City for the AIEE's 64th summer general meeting, the first to be held so far outside of the continental borders of the United States. The meeting was held from June 21 to 25 with registration and administrative activities at the Del Prado Hotel and technical sessions and related activities at the Teachers College (*pages 784–6*).

Annual Meeting. The Institute's 64th annual business meeting was held on June 23, 1948, during the summer general meeting in Mexico City, with B. D. Hull presiding (*pages 787–8*).

AIEE Conferences. Further details concerning the AIEE-Institute of Radio Engineers conference on electronic instrumentation in medicine and nucleonics and the AIEE conference on electric welding appear in this issue (*page 780, page 781*). It will be recalled that this new type of AIEE conference was initiated in March of this year by the conference on electron tubes for instrumentation and industrial use, which was followed in April by the conference on electrical engineering aspects in the rubber and plastics industries. A number of other interesting conferences are being planned for the future, as a glance at the AIEE future meetings box will indicate (*page 781*).

Pacific General Meeting. Spokane, Wash., will be host city to the 1948 AIEE Pacific general meeting to be held August 24–27. A broad technical program has been announced which will be of special interest to western engineers, and a number of inspection trips and social events have been planned including an interesting program for the visiting women (*pages 788–9*).

Board of Directors' Report. The 64th annual report of the board of directors of the AIEE for the fiscal year ending April 30, 1948, is presented herein. It includes a brief summary of the Institute's activities during the year, as well as a balance sheet and other statements reflecting the AIEE's financial condition at the close of the fiscal year (*pages 804–25*).

AIEE PROCEEDINGS. The fifth *PROCEEDINGS* order form, for papers presented at the Great Lakes, North Eastern, and summer general meetings, appears in this issue (*pages 45A–46A*).

Digests. One-page digests appearing in this issue include the digest of one technical paper presented at the North Eastern District meeting of the AIEE plus several digests from the recent summer general meeting in Mexico City (*pages 734, 741, 747, 748, 758, 768, 773*).

Electrical Essay. Is there a diamagnetic hysteresis in this imperfect world? This question is posed in the latest of the series of electrical essays which *ELECTRICAL ENGINEERING* is presenting for the entertainment of its readers—and which have elicited very gratifying response (*pages 771–2*).

New Officers and Committees. AIEE officers and committee personnel for the year 1948–49 have been announced and are listed in this issue. This listing is presented as correct as of the date of publication, however it may be subject to further revision and correction (*pages 793–803*).

Wallberg Lecture. An exposition of the breadth of engineering provides the subject for Doctor Harvey N. Davis' Wallberg Lecture, first in a series of lectures in memory of Emil Andrew Wallberg, Canadian engineer (*pages 727–33*).

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Lamme Medalist. The Lamme Medal for 1947 has been awarded to Alexander M. MacCutcheon, retired vice-president of the Reliance Electrical and Engineering Company. The addresses accompanying the presentation of the medal during the summer general meeting in Mexico appear in this issue (*pages 749–53*).

Microwave Spectroscopy. The absorption of high-frequency electromagnetic waves by gases which possess electric dipoles can be used to obtain information regarding the spin of the atomic nuclei within the molecule, the charge distribution within the nuclei, and in some instances bond distances and the position in the molecule of particular atomic isotopes. The development of detection and analysis methods and equipment for obtaining these data are discussed (*pages 735–40*).

Microwave Attenuators. A new class of materials consisting essentially of conducting particles dispersed in dielectrics whose function is to attenuate microwaves has been developed as a result of the war-born expansion of radar and microwave systems (*pages 754–7*).

Steel Industry Electrification. For the past 25 years the steel industry has been becoming more and more electrified. So much so, that a number of processes themselves have been redesigned around the electric equipment, in order to make full use of its advantages (*pages 774–5*).

Mile-a-Minute Rolling Mill. The new 42-inch 5-stand tandem cold reduction tin-plate mill now in operation at the Weirton Steel Company, Weirton, W. Va., uses a total of 17,550 horsepower in the mill and reel motors, the largest amount of power ever concentrated in one tin-plate tandem mill. The control and co-ordination of these electric drives presents a challenging task to the electrical engineer (*pages 742–6*).

High-Energy Accelerators. The ninth article of the series developed by the AIEE nucleonics committee reviews the construction and operation of four basically different types of modern machines for producing high-energy charged particles in the one million to ten billion electron volt range. The variations of each type of machine also are described. A consolidated pamphlet of reprints including the entire series will be available to interested readers upon conclusion of the series (*pages 759–67*).

Fault Currents. Tests of arcing faults on a-c circuits show that on busses with 4-inch spacing the faults are unstable and will extinguish themselves at voltages up to 250 volts, and that half of the line-to-line arcing faults on 500-volt circuits are unstable; the sustained current in the latter instance may be less than 0.8 of the bolted symmetrical current (*pages 769–71*).

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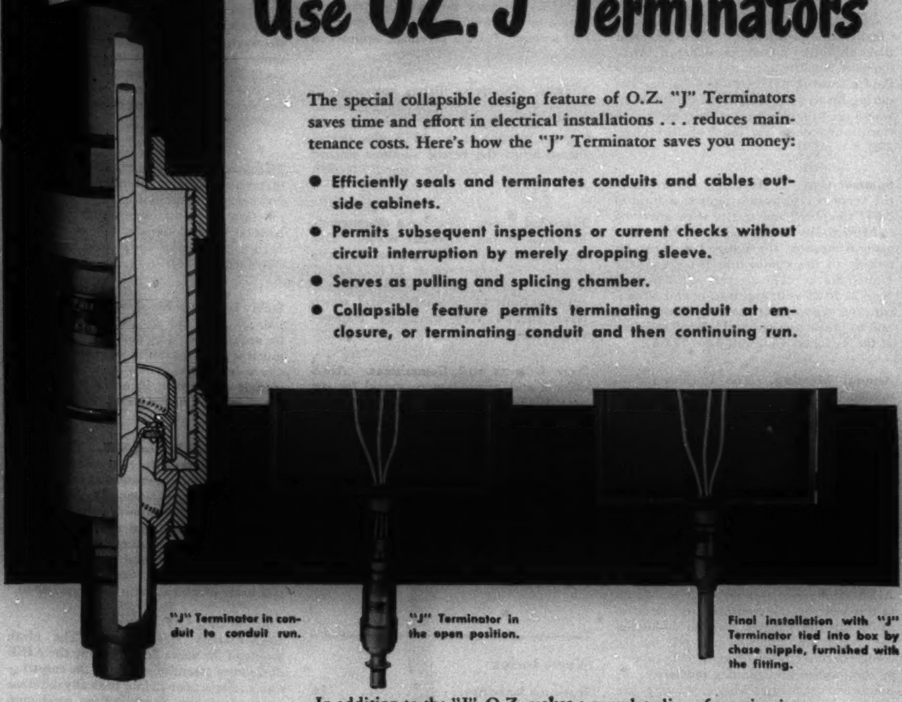

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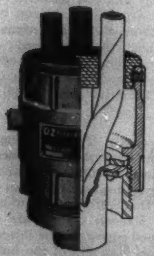

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The Engineer's Part

HARRY N. DAVIS

This first Wallberg lecture inaugurates a continuous series of Lectures instituted by the University of Toronto to perpetuate the name of Emil Andrew Wallberg, Canadian engineer, industrialist, and philanthropist. Mr. Wallberg's achievements were associated particularly with the promotional and industrial aspects of engineering.

EMIL Andrew Wallberg, engineer, industrialist, and public-spirited philanthropist, whose name is being perpetuated both by these Wallberg Lectures and by the University of Toronto's new and magnificent building devoted to the science and art of chemistry, seems to have exemplified those very traits and activities of the engineer with which this article is concerned. The memory of this great and good man should be a potent educational influence that will warm the heart, augment the professional pride, intensify the ambition, and strengthen the high ideals of every student in the university through many future college generations.

It is significant, even if not unusual, that the new building will house both chemistry and chemical engineering. It long has been an element of strength in academic chemical departments, as contrasted with those of physics, that the chemists have kept theory and application close together, and have trained their future research men, their future industrial practitioners, and their future teachers, as well as their undergraduates, all as members of one family, whereas physics long since let its practical men enlist under other banners as engineers. That is why departments of chemistry until recently have seemed to outshine physics departments in colleges and universities as regards both number of students enrolled and financial support. Only in this new electronic and nuclear age are theory and practice in physics teaming up, as they long have teamed up in chemistry. Only now, in physics, is the sharp distinction between a scientist and an engineer beginning to disappear, to the great advantage of both.

This close relationship between theory and practice, between so-called pure and so-called applied science, that long has existed in the chemical field, and now is emerging in physics, is significant of a trend that rapidly is gaining momentum. Some of the older branches of engineering developed as arts long before there were any foundations of true science upon which they could rest. Men successfully built structures long before they had formulated the fundamental laws of statics, of elasticity, or of what we now call the strength of materials. The steam engine was developed commercially before anybody had conceived of entropy, of absolute temperature, or even of the law of the conservation of energy. Even now we are becoming expert in the metallurgy of alloys, and in the use of catalysts and organisms to promote useful chemical reactions, while still awaiting the clear vision of comprehensive fundamental principles that both would systematize what we already know, and guide us in new advances. I suppose that we always shall have this kind of progress in the practical arts of the engineer. Flashes of genius will continue to lead men into new fields, into new ways of doing things, that cannot be predicted in advance; only afterward will come the rational explantions of what has been accomplished. Nevertheless, more and more progress in the arts of engineering is stemming from widespread, sound, deep knowledge of the fundamentals of mathematics, physics, and chemistry. More and more must we stress these fundamentals in the more elementary parts of our engineering education, even if, to make room for them, we have to crowd out much of that description of current procedures and practices, of currently used machines or processes, that is so easy to give and so entertaining to listen to.

Engineering education, at least in the United States, has been going through a phase of great and highly detailed diversification. The Engineers' Council for Professional Development has accredited more than 20 different kinds of engineering curricula, training men for not only the traditional civil, mechanical, electrical, chemical, and mining branches of the profession, but also for such special fields as aeronautical engineering, textile engineering, petroleum engineering, ceramic engineering, gas engineering, agricultural engineering, and the like. All these curricula rest on the same foundation of mathematics, physics, and chemistry, on calculus, elasticity, hydrodynamics, electrical theory, and thermodynamics including physical chemistry. They differ from each other chiefly in the descriptive matter relating to current practice in their various fields to which students are exposed, and in the types of practical experience which students are expected to gain in various specialized laboratories. Some of the engineering schools in the United States have full-sized rigs for drilling oil wells set up on their campuses. Some of them have their own flying fields. I remember seeing in one of them a beautiful Jacquard loom which is a machine for weaving textiles with intricate designs, controlled by a long endless chain of plattens of heavy cardboard, each perforated by many carefully spaced holes. The loom presses each platten in turn down onto a bed of movable pins, one for each thread of the warp, thereby determining which threads shall be raised, and which left depressed, for each passage of a shuttle, and which of several shuttles shall pass. Each student in this laboratory is

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Essentially full text of the first Wallberg Lecture, delivered on January 27, 1948, at the University of Toronto, Toronto, Ontario, Canada.

Harvey N. Davis is president, the Stevens Institute of Technology, Hoboken, N. J.

expected not only to design, but actually to make with his own hands, a chain of plattens that will make the loom weave a run of, let us say, washcloths that say "God bless our home," or bear the insignia of his fraternity, or, for all I know, the picture of his best girl, or any other design that pleases him; finally he has to put the chain of plattens on the loom and prove that it works. I was not informed whether producing one washcloth was his limit, or whether he was allowed to run off 100 if he wanted to.

All this produces a crop of young engineers who have commercially useful skills, each in his own field. An employer of such a graduate is likely to get his money's worth almost from the start if the young man's skill fits the employer's need. And yet the trend in engineering education in the United States is, I believe, away from this sort of undergraduate specialization. As modern engineering practice, in all its ramifications, comes to make more and more use of mathematics, often in some of its surprisingly high or abstruse phases, and of the most modern developments of physics and chemistry, so will we in the engineering schools have to lay more and more stress on the fundamentals, thereby crowding out the technical details. That is, we shall have to train our young men more and more for adaptability rather than for informed skillfulness. Our aim must be, not to teach them engineering, but rather to prepare them to learn engineering for themselves on the job throughout their lives.

I believe that the British schools are better than those in the United States in throughly grounding their engineering students in mathematics and the sciences. Where Canada stands in this important matter I do not know. I suspect, and hope, that Canada is more like the British than like us in the United States. I even hope that some in Canada are doing, or will do, what some are trying to do in the United States, namely train young men in the fundamentals of engineering as such without any designation or limitation of field whatever. Men so trained have the advantage of knowing when they graduate that they do not know much of anything of a practical sort, and thereby are inspired to strive with particular assiduity to learn all they can while they work in whatever field their lot proves to lie.

WHAT IS AN ENGINEER?

First, what do we mean by an engineer? There are many definitions, some of them quite sharply limited in scope. For instance, in New York and in many other states no one legally may call himself an engineer unless he has been licensed by the state after scrutiny of his experience and after two examinations four years apart, in one of which the theory of structures plays a considerable part. In these states every blueprint prepared for a client must carry the signature of a licensed engineer. On the other hand, in the idiom of the Bell Laboratories in New York City, an engineer is a research and development man. Often he originally was trained as a physicist, or even as a mathematician, and his work is often largely what would be called pure science in any other environment. And then there are, in the United States, many firms specializing in industrial or market surveys, or acting as consultants on industrial organization and management, that carry on their letterheads the proud word "engineers."

In the face of all this diversity of usage, I, personally, like to give to the word "engineer" a very broad, inclusive meaning, making no distinction between engineers and pure scientists on the one hand, or between engineers and a large group of industrialists on the other hand. In my vocabulary, any man who has adequate technical training in any part of the great field of the natural, as distinguished from the biological and the social, sciences is a member of our family. More particularly, any graduate of a school of engineering is and remains one of us, no matter into what kind of activity the development of his career may lead him.

This is, I admit, a pretty broad definition. Under it, to cite some examples chiefly from among the alumni of the Stevens Institute of Technology, there are engineers who are practicing law, lots of them, especially, of course, but by no means exclusively, in the field of patent law. There are engineers practicing medicine. One of them came to Stevens with his mind already set on a medical career before he entered; he is now head of the department of ophthalmology in one of the great New York medical school hospitals. Another Stevens graduate, a dentist, is a recognized authority in his specialty, which is bridge work. No, I am not feeling my way toward a play on words. He claims that building a bridge across a river 50 feet wide and building one across a quarter-inch gap in a mouth are one and the same problem. In both instances, one deals with loads and bending moments and abutments and thrusts against them. The only real difference seems to be that in the case of the 50-foot bridge one usually can count on one's abutments being fairly well fixed in position.

There are also engineers in banks, in investment houses, and in insurance companies. There are engineers working on various phases of the social sciences, particularly economics, and also sociology, if applied psychology on the one hand, and labor relations on the other, are indeed branches of sociology. There are of course thousands of engineers in industry, both in staff and in line positions. Indeed, this field takes well over two-thirds of the engineering graduates, not only at Stevens, but throughout the United States. There are engineers who are ministers of the gospel. One of the most distinguished of Stevens alumni once said that he felt that his engineering training had done him a world of good in his work as an Episcopal clergyman. There are also engineers who are professional artists. Calder, with his well-known "mobiles," and the late Eugene L. Vail, whose paintings are hanging in half a dozen leading art galleries in the United States, are both on the Stevens alumni list, and Doctor Karapetoff, formerly a professor of electrical engineering at Cornell University, who recently died, was a distinguished professional pianist. I even might add that Rube Goldberg, the cartoonist, and Arthur Murray, the dancing teacher, are both graduates, not of Stevens, but of other American engineering schools.

My broad definition of an engineer is very inclusive. In my view every one of these men has done a different kind of job in his career from what he would have done in that same career if his college training had not been in engineering. I do not mean that these men necessarily have done better jobs than their arts-college trained colleagues in similar careers, though most of them have done distinctly well. What I do mean is that, because of their engineering training, each one of them has brought a somewhat different, a somewhat unique, point of view to his work that has played a useful part in the general thinking in his field. If that be so, why should we disown him as having abandoned engineering? As someone once said of the city of Boston, engineering is not a particular area in the field of human endeavor; it is rather a point of view, and any one who once has had it keeps it no matter where his work lies.

THE ENGINEER'S PART

And now, at last, we come to the engineer's part. His most obvious, and perhaps his most important, task is to keep modern civilization running. Upon him, and upon his subprofessional technical associates, falls the responsibility for the operation and maintenance of the whole material basis of modern living. Consider, for a moment, what would happen if at midnight tonight by some miracle all the engineers and all their works were to vanish. Neither this great city nor any other, could survive a week. All transportation being gone, neither food nor water could be brought in nor could any considerable number of people escape to the haven of a farm. There would be no electricity or fuel, and so no light or heat. There would be no communications, no news, no books or magazines, and soon no thinking above the level of animal cunning, and very little scope even for that. The civilized world would die, both mentally and physically, except, perhaps, for a few scattered survivors who would have to recreate a new stone age, or learn from their uncivilized neighbors how to live. Thank God that all this is only a lurid dream.

Equally obvious, and almost equally important, is the engineer's role in *improving* the material basis of civilized living. To him we owe always the design and construction and often the conception, of the great bridges and tunnels, the highways and railroads and airports, the waterworks and dams, the central and scattered power plants and distribution systems, the steamships and locomotives and airplanes, and all the other things that make up the permanent plan of a modern community. Not only must all these things be maintained and operated, but new ones must be added continually, including, often, wholly new kinds of things, as populations shift and increase, and standards of living rise.

To the engineer we also owe much of the invention, and practically all of the development, of the machines and other gadgets that make modern living what it is. To him we therefore look with confidence for a host of new machines and gadgets in the future that will make the necessary work of the world still easier to do, and thus lay the basis for still wider and deeper education, and for more significant thinking and creative imagination.

One aspect of these traditional activities of engineers, namely operating, maintaining, and extending the material side of civilization, deserves attention. In a free-enterprise economy, what we call prosperity seems to be intimately associated with those surges of production of new capital goods that commonly are caused by the emergence and growth of some great new industry. This is because the cost of producing the new capital goods, which is in the last analysis almost wholly wages, greatly increases the available purchasing power within a community without providing an immediate corresponding increase in the supply of consumer goods. Then demand goes up, prices firm, the consumer goods and service industries respond, employment increases, wages tend to increase, and the boom is on. If all this does not occur too rapidly, if unbridled optimism does not run rampant, as it did in the United States in 1929, if pure speculation as distinguished from constructive foresight does not get into the saddle, and particularly if the growth of the new industry is maintained steadily over a considerable period of time, the resulting prosperity is widespread, healthy, and socially significant. An excellent example of such a train of events was the emergence and growth of the automobile industry with all its ramifications during the first two decades of this century. Then followed, in fortunate timing, the growth of the radio industry and of broadcasting, with its accompanying general prosperity. Then came aviation. What its contribution might have been under normal conditions no one can say. What it actually did was to win a world war and then leave an aftermath of terrific overexpansion, which is part of our great and confused postwar problem. The new electronics developments such as radar and loran are pretty much in the same boat. Now, as we plunge forward into an uneasy peace, it will be a godsend if some other great new industry emerges. If it does, engineers will be in the midst of it, and responsible, certainly for its growth, and quite possibly for its inception.

Where to look for the next great new industry is, of course, anybody's guess. The man in the street doubtless would tell you to look to either television or nuclear energy. Personally, I doubt if either of them is destined to play so important an economic part in the general picture as did the automobile and the home radio, at least not during my lifetime. If I had to guess 20 years ahead, my hunch would be that the next economically important great new industry will not be a single industry at all, but a group of industrial developments in the field of the heavy chemicals, including, of course, a lot of chemicals, organic as well as inorganic, that we do not now think of as heavy chemicals in the sense of being produced in carload lots.

These are the activities and functions of the typical engineer as the public thinks of him, the practicing technical engineer, the man who thinks of himself as an engineer, and is so regarded by his neighbors, throughout his life. His work is temendously important. If it seems to have been treated too cursorily in this article it is only because it all seems so obvious to me, and because I hope to persuade you that it is by no means the whole story in any discussion of the engineer's part.

THE ENGINEER IN ENGLAND AND AMERICA

As a prelude to my further remarks, I should like to tell you about one of the things I learned when I had the privilege of being in London for five weeks just after the blitz. When I asked some of my British friends about the status of engineering education in Great Britain both during and before the war, they told me that in the prewar years the great provincial universities had been graduating some 800 to 900 cadet engineers per year. To these, the University of London, through its various affiliates, was adding something more than 100 more. In all, then, Great Britain was turning out around 1,000 engineering graduates in a typical prewar year. At that time the population of the British Isles was roughly a third of that of the United States. By the rule of three the United States then should have been turning out about 3000 engineering graduates per year. We were in fact turning out 12,000 to 14,000 per year. Why this discrepancy?

Further inquiry revealed that when the British graduate a young engineer, he is pretty strictly a technical man. He knows his mathematics and his basic science. He knows a lot of engineering too. He expects to practice the profession of engineering all his life. If he goes into industry, as he usually does, he goes as a techinical man, and the top of his line of promotion is commonly the position of chief engineer of his company. If he presently branches out on his own, it is as a consulting engineer in his technical specialty. Very seldom does he become the managing director of a great industrial enterprise, the managing directors being commonly either lawyers or financial men. At least I was given to understand that that was the general picture before the war, notwithstanding some notable exceptions.

Whether the British picture is still like that or not, I do not know. Nor do I know whether the picture in Canada is, or indeed ever was, like that. Mr. Wallberg's career makes me think otherwise, for he, an engineer, held at least two notable industrial presidencies. But I notice that he got his engineering training in the United States. Nevertheless, even if we predisposed the bent of his mind, Canadians accepted him and promoted him into his positions of administrative responsibility.

Returning to the British picture as compared with that in the United States, you will notice that, if you confine your attention to that fraction, roughly one-third, of engineering graduates in the United States who, before the war, were heading for the practice of the technical profession of engineering as such, our output of them per year per 100,000 of population was not markedly different from that of the British. In their case the figure was around $2^1/_4$ while for the United States the figure was $2^1/_2$ to 3. In both instances, the figure is likely to increase, though not spectacularly, as civilization becomes more intricately mechanized. The figure will have to be considerably higher during the next five years in the United States, to make up for the disastrous interruption in engineering education inflicted on us by our particular brand of selective service system.

Fortunately the "G. I. Bill of Rights," coupled with the current popularity of engineering education, is providing at the moment, an abundance of engineering undergraduates. But, as of ten years hence, I suspect that something like four engineering graduates per year per 100,000 of population adequately will supply the needs of the strictly technical phases of the engineering profession in all three countries.

Nevertheless, this is far from the whole education story. I already have indicated that schools in the United States are graduating at least three times as many engineers as are needed in the technical phases of the profession. What are the rest doing? The answer is that by far the greater part of them are in industry.

Instinctively many men with engineering training are production men. Their work is in factories, large and small. They lay out plants and assembly lines. They plan production methods and scheduling. They arrange for the smooth flow of materials into, through, and out of the factory. They watch for and strive to eliminate bottlenecks. They improve old ways of doing things and experiment with new ways, such as the fabrication of machine frames by welding instead of casting, and the elimination of machining by precision casting and powdered metal techniques. They use job-simplification techniques, sometimes called motion-study, to lessen fatigue and increase production. Often one finds them in the direct line of command of the production force.

Personnel departments also frequently are staffed by engineers. There they find and hire the new recruits made necessary by labor turnover, or needed for expansion. They use psychological tests not only in selecting new personnel, but also, and this is likely to be of rapidly increasing importance, in shifting old personnel into new positions where they seem likely to do more congenial as well as better work. They formulate job specifications. They set rates, with or without time-studies. They investigate employee grievances. They also strive to understand that elusive thing called morale, and the deep-lying sources of employee satisfaction, of contentment, and of ambition. Often one finds them grappling with the current problems of labor relations, where their training and experience is likely to make them more understanding of the points of view of both sides in a controversy than are their legal or financial colleagues in management.

Sales departments, also, particularly those of factories producing producer's goods, are providing a rapidly growing demand for engineers. The technique of selling equipment, such as machine tools, to other factories, is, obviously, quite different from that of selling consumer goods, such as packaged foods or even refrigerators and automobiles, to the general public. The latter type of activity has been much studied. Market analyses, methods of distribution, and the wiles of advertising all have been made the subject of many speeches and papers, and schools of that type of salesmanship abound. To sell a new or improved machine tool to an automobile manufacturer is, however, quite a different story. His purchasing agent is himself an engineer, to say nothing of the production men for whom he buys, and so it pays to send a salesmen who talks the same language and thinks in the same terms. Furthermore, each such selling adventure is, in itself, a research project of considerable magnitude, for what is being sold is not merely a machine but a predictable effect on the prospective customer's business. That fact defines the terms in which the salesman must think and talk if he is to be successful. Often he becomes a sincere, competent, and welcome consulting engineer, rendering a real service to each successive customer, whether the particular sale in question goes through or not. I remember once meeting two Stevens graduates who were representing a famous maker of boilers in a mid-western city. When I asked some other local engineers how these men were doing, the answer was somewhat as follows, "Those two men have the reputation around here of knowing more about each and every power plant in this area than the man that owns it does. The result is that when any change is contemplated the owner calls in one of those men and asks what should be done, and the man tells him. If somebody else's line happens to fit that particular case better than the salesman's own line does, he says so frankly, and then gets his home office on the telephone and asks that their development men see to it that he isn't caught that way again. Meanwhile that customer is his friend for life and plenty of good business lies ahead." That is modern sales engineering, and only engineering-trained men are likely to become expert at it, as more and more of them are discovering every year.

The relative importance of this managerial side of the work of engineers, at least as measured by the numbers of men involved, can be illustrated by another group of facts that came to my attention a few years ago. Just before the war one of the largest aeronautical companies in the United States undertook the design and development of a new model in its well-known line of aviation engines. They told me that it took some 300 engineers three years to bring the new design through to the production stage. By that time we were in the war, and the company built a big new plant for the production of the new engine in quantity. This involved some 700 engineers working at top speed for a little over one year, which was a wartime record. The significant fact for our present purpose is, however, that even after the new plant was completed and in full operation, it took 500 engineers to keep it running. They were the management men I have been talking about.

What this meant was that 300 men working for three years and 700 men in a one-year spurt, that is some 1,600 man-years of technical engineering effort, concentrated into less than five years, created a continued need for 500 management engineers for as long as the plant ran. As it happened, the active life of that wartime plant was not very long. But consider what the corresponding situation would be with respect to a peacetime development. The designing and construction teams would finish their work on one project and turn to another every four or five years, but the management men would stay on the job indefinitely, and a new group would be needed as each new project came through to production. Suppose this were to happen with respect to three projects in a 15-year period, and that we take the airplane engine figures as typical. Then each three or four technical engineers working through the 15-year period would have created permanent jobs for some 15 management engineers working steadily thereafter. The indicated ratio of needed men is four or five to one. Indeed, if one assumes that the active professional life of the technical men is 30 years instead of 15, which is doubtless nearer the truth, and that each successive project they take up comes through successfully, which is, unfortunately, not quite as probable, one would conclude that we ought to be turning out eight or ten management men from our engineering schools for every strictly technical man that we graduate. Doubtless this ratio will turn out to be too high, so please do not swallow it whole. But, as New Englanders say, "it gives one to think!"

The fact that management is becoming more and more recognized as a branch of the engineering profession is not a new trend. It stems back at least to 1880 when the first president of the American Society of Mechanical Engineers, Robert Henry Thurston, then a professor at Stevens Institute of Technology, said in his inaugural address, printed on page one of volume one of the society's *Transactions:* "The class of men from whose ranks the membership of this society is principally drawn direct the labors of nearly three millions of prosperous working people in a third of a million mills and other manufactories, are responsible for the preservation and profitable utilization of 25 hundred millions of dollars' worth of capital, direct the payment of more than one thousand millions of dollars in annual wages, the consumption of three thousand millions of dollars' worth of raw materials and the output of five thousand millions of dollars' worth of manufactured products." This indicates clearly what Thurston thought the engineer's part was 68 years ago. Six years later Henry Robinson Towne, who subsequently became the eighth president of the society, read a paper on "The Engineer as an Economist," and I might add incidentally that the ninth president gave as his presidential address a companion piece on "The Engineer as a Scholar and a Gentleman." It was before this same engineering society that Frederick Winslow Taylor, a Stevens graduate, read in 1903 his famous paper on "Shop Management," and it was Henry L. Gantt, another Stevens graduate, who did much to make scientific management the potent influence on industrial organization that it has proved to be ever since.

In recognition of all these facts, the ASME has had for 27 years a professional division called the management division, and has added more recently five other professional divisions in related fields, one on production engineering, one on materials handling, one on metals engineering, one on the process industries, and one on the wood industries.

Perhaps you now see why I like to regard the industrialist, Emil Andrew Wallberg, as a shining example of by far the largest branch of the great engineering profession. Perhaps you see also why schools in the United States already are training at least three times as many engineering students as are needed in the traditional, strictly technical branches of the profession. It is my personal belief that this ratio is bound to increase rather strikingly in the years that lie ahead. There is something about the way a technically trained man thinks, about his way of first getting together all the readily available data, then coming to a decision, and then doing something about it, that seems to fit well into modern industry. Someone once defined an engineer as a man who could guess right seven times out of ten on insufficient data. Of course if he has completely sufficient data, he guesses right ten times out of ten; but then he is not an engineer but an exact scientist. This old definition takes illuminating cognizance of the fact that the engineer continually is dealing with problems where completely sufficient data cannot be had. In particular those aspects of his problems that depend on the behavior of human beings, whether they be workmen, possible customers, or the public, never can be appraised with comforting completeness or accuracy. Nevertheless the engineer has to decide and then to act. If subsequent events show that he usually guesses right, he is a great engineer.

What the ratio of total engineers to technical engineers, which in the United States is now about three, will increase to in the near future is anybody's guess; my guess is that it soon will be five or six, and it even may grow to the eight or ten I mentioned a moment ago. This means that in the United States engineering schools should be graduating at least 20 and perhaps even 30, cadet engineers per year per hundred thousand of our population, even after the present postwar bulge has subsided. The figure before the war was already over ten. Of these 20 or 30 perhaps four will be professional engineers of the traditional type. The rest of them will scatter widely into many careers, but most of them will be industrial men of one kind or another.

TRENDS IN ENGINEERING EDUCATION

This considerable extension of the field of the engineer into industry has certain implications to which we who are educators should not be blind. In particular it changes somewhat the aims and objectives that should guide us in such matters as curriculum making. If from two-thirds to four-fifths of our graduates are going into industry, many phases of economics, ranging from accounting to pure economic theory, and such branches of sociology and psychology as bear on labor relations, employee morale, customer preference, and public relations generally, deserve more attention than sometimes is given in a technical curriculum. Also the study of English is far more important than most educators realize, or than any engineering undergraduate is willing to admit. An extensive, accurate knowledge of the exact meanings of words has been proved to be the most universal and most striking characteristic of 200 major business executives who were studied exhaustively some years ago. Furthermore, a brief statistical study once made at Stevens showed that unusual improvement on a standard English vocabulary test as between the beginning and the end of the freshman year, correlated clearly with unusual success in even the technical work of the sophomore year, and also with honors at graduation. The importance of being able to read rapidly, and to write and speak effectively, cannot be emphasized too much.

A good background in literature and history, and a keen and intelligent interest in current affairs, are also important to an industrialist whose contacts, both professional and social, often will be with men educated in arts colleges. And finally the sort of physical education in college that aims at producing, not star athletes, but men with fit, well co-ordinated bodies, men who look healthy and move gracefully even if they can not break 90 at golf—that sort of physical education can afford a physical basis for later leadership that is well worth striving for.

All this is possible only if we are willing to give up the idea of offering much technical specialization in a 4-year undergraduate engineering curriculum. This is why some of us believe that specialization should be left for postgraduate work, or for self-education on the job, and in our undergraduate schools we should stress only the fundamentals, and strive mightily to inculcate self-reliance and adaptability rather than mere technical competence. In other words, we believe that an engineering school can provide the best possible sort of liberal education for life in this 20th century for an increasingly numerous group of young men who are fitted by temperament, inclination, and early training to take it. Not that I would urge all men, or even all of the ablest young men, to forsake the arts colleges and study engineering. Far from it. The arts colleges have a tremendously important part to play in the general scheme of things, and many more men belong in them than belong in engineering schools. But those who do fit into our picture can, and should, become far more than mere technicians, narrowly trained, and able to make only a specialized, even if highly competent, contribution to the life of the world they live in.

THE ENGINEER AS CITIZEN

And so I end my discussion of the engineer's part, *as an engineer*, in modern life. But before I close, I want to say one thing about the engineer's part as an intelligent, well-educated citizen.

I do not believe that technical men, as a group, are usually well fitted to play useful parts in public life by seeking elective offices. It is a characteristic of democracies that the personal qualities that help a man to secure an elective office have little in common with the personal qualities that are needed to discharge ably many of the duties of the office after the man has been elected. To be a successful candidate, a man must have the happy faculty of being able to focus the spotlight on an individual, namely himself. On the other hand, the instincts and training of a technical man tend strongly to make him want to focus the spotlight not on any individual but on the job as a whole. That usually makes the technically minded engineer a fine member of a team on a big project, but an inept politician. If we are to look to engineers for effective participation in political life, we must, I think, look to those who have gone into industry rather than to those whom the world still calls engineers.

But I do believe that all engineers, technical men and industrialists alike, can make a specific and important contribution to the thinking of the nation, particularly in the field of economics.

I say this in all humility, being not unaware of the wisdom of Rebecca West's warning in her latest book against assuming "that the man who possesses a special gift will possess also a universal wisdom," and her scorn of those "who are unaware, in their arrogant innocence, that the study of physics or chemistry is no more likely than the study of harmony or counterpoint to develop social omniscience in the student."

Far be it from me to claim social omniscience for engineers and yet we do have one habit of thought, apparently not common among economists, that may have economic significance. We think instinctively in terms of what we call continuity theorems.

A continuity theorem stems from the combination of a concept of the flow of something with the general concept of the conservation of matter or of energy as the case may be. Kirchhoff's second law is an example. It states that in an electric network, no matter how complicated, the sum of all the currents flowing into a given node or junction point must equal the sum of all the currents flowing out of it. Another example is that of a reservoir in a city water system. It may be fed from distant sources through one or several incoming trunk mains. It supplies the city through several outgoing feeder mains. The continuity theorem states that if the sum of all the incoming flows is not equal to the sum of all the outgoing flows, the difference will be accounted for exactly by an appropriate change in the water level in the reservoir, provided of course, that there are no springs or leaks in the floor of the reservoir. A third example is the heat balance that an engineer makes for a central-station power plant. He starts with an intake of so much fuel per hour or per day which brings with it so much heat energy. This flow of energy he proceeds to account for. Some of it went up the stack. Some went as unburned fuel into the ash pit. Some was lost by radiation from the boiler setting. The rest went into the steam produced and was carried by it over to the prime mover. Most of that flow of heat went into the condensing water, and there were also some more radiation losses. The rest is turned into mechanical and then into electric energy, though along the way there are losses due to mechanical and to electrical friction. Finally so much power is delivered to the bus bars. Each of these outflows of energy is measured or estimated separately, and the sum of them is compared with the inflow of energy brought in by the inflow of fuel. Seldom does the accounting fail to balance by more than one or two per cent. All these are examples of continuity theorems.

TECHNICAL THINKING IN ECONOMICS

It is my contention that this kind of thinking, which is instinctive among technical men, is also significant in many phases of economics. Not that it is ever by any means the whole story; but whenever a technical man injects a continuity theorem into an economic discussion, something is gained in the clarity of everyone's thinking.

For instance, in discussing foreign trade, it still frequently is assumed that a "favorable" balance of trade means an excess of exports over imports. An engineer visualizes foreign trade as largely a complicated flow of goods, of real tangible things, and of services. He realizes that counterbalancing flows of money, in the form either of gold or of credits, enter into the picture; but he feels instinctively that except for the payment of carrying charges on capital invested abroad, these flows of money cannot, in the long run, play a large part in any stable flow of goods and services. He therefore concludes that any nation other than one heavily in debt to foreigners ought not to want a so-called favorable balance of trade. In particular, he concludes that a creditor nation, like the present United States, ought to welcome imports of everything that can be produced abroad more effectively than at home, and ought to long for a considerable so-called unfavorable balance of trade. The engineer realizes that this may not be the whole story, but he cannot understand why this point of view should not have more attention than it seems to get from the politicians.

As another example, consider what is meant by the standard of living of a community or a nation. An engineer thinks of this as the per capita flow of goods and services into the hands of ultimate consumers. Anything that increases this flow of goods and services raises the standard of living, and contrariwise. Furthermore, nothing can be consumed that has not been produced first. Therefore the production level of a community or a nation is the most basic factor in its economic picture. Whatever increases total production is, as far as this kind of reasoning goes, good. Whatever decreases total production is bad. On this basis, an engineer cannot help feeling that industry-wide strikes such as have been occurring in the United States recently, which are attempts to divert a greater part of the flow of goods and services from a vast majority into the hands of a militant minority by means which materially lessen the total flow to be divided, are detrimental not only to the nation as a whole but also to labor itself. Neither can he help feeling that feather-bedding, arbitrary limitation of individual output, refusal to use labor-saving machinery, refusal to train apprentices, and all the other self-protective devices of modern trades-unionism are detrimental not only to the nation as a whole, but also to labor itself. In the engineer's view, what labor ought to seek is not higher money wages offset by spiralling prices, but rather increased production per man-hour, lower prices, and higher real wages as measured by everybody's standard of living. Again the engineer realizes that his continuity-theorem type of reasoning is by no means the whole story. But again he cannot understand why this point of view should not have more attention than it seems to get from labor leaders.

On the theory that whatever helps production helps the world, an engineer likes the aims and objectives of the Marshall Plan for rehabilitating Europe by making increased production possible there. But by the same token he does not like the Truman Plan of distributing a 40-dollar dole to all and sundry at the expense of productive industry, or the other popular plan of "soaking the rich" by means of excessive income taxes. In both cases he sees an inevitable diminution in the venture capital that should be invested in means for increasing per capita productivity.

All this, and much more, is the contribution that the engineer is able, by virtue of his training, to make to the general thinking of the time. Of course many others have many other equally important contributions to make, with which his contribution must be fused into an integrated, well-balanced whole of economic and political thinking. The engineer's part is to stick to his guns, without conceit, dogmatism, or disparagement of the contributions of others, but with confidence that his contribution is worth making, and with firm faith that the final synthesis of public thinking will lead to wise action beneficial to all.

Would that each one of us could feel at the end that, in all these ways, within the limits of his powers, he had done as much for the public good as did Emil Andrew Wallberg.

Electricity in Land Transportation

CHARLES KERR, JR.
MEMBER AIEE

COMMERCIAL land transportation embraces the transportation of passengers in urban communities and the intercity transportation of both freight and passengers. In the United States alone, this industry operates in excess of 175 million horsepower. No other industry offers the electrical manufacturers a commensurate opportunity for expanding the use of electric equipment.

Commercial transportation in urban communities is a most essential public service that can be furnished by the motor bus, the trolley coach, the streetcar, and the rapid transit train. Those three types of vehicles which are operated electrically generally provide a better service, and except on routes of light traffic density, do so at a lower operating expense.

In recent years, the electric apparatus for the trolley coach, the streetcar, and the rapid transit train has undergone a rather complete transition. These changes have been brought about by a need for greater standardization to reduce first and operating costs, and by a realization that continued public patronage could be secured only by better transportation service. These modern electric vehicles give the fastest and most comfortable ride ever available to patrons of city transit. In very large metropolitan centers, city transit may be supplemented by the commutation service of the main line railroads. Over 50 per cent of the passengers patronizing this service now are hauled in electrically operated trains.

By far, the largest potential concentration of power in commercial land transportation is represented by main line locomotives. Their estimated total capacity in the United States is 125 million horsepower, or about twice the present installed capacity of all central stations. Electrification, which first introduced electric traction, remains the best means yet devised for the operation of a railroad. Its relatively large initial investment generally has restricted its acceptance to lines of heavy traffic density where better over-all economy can be secured. The Diesel electric, which is essentially an electric locomotive carrying its own prime mover, has expanded the use of electric traction on a far broader scale. The coal-burning steam turbine locomotive now has adopted the electric drive and the coming gas turbine certainly will do likewise.

The electric transmission for locomotive service has demonstrated so many outstanding advantages that its almost universal use seems highly possible. Electrical engineers have dreamed for many years of the day when the railroads might be electrified. That day may come, with electrification consisting partly of electric locomotives receiving their power from central power stations, and predominantly of electric locomotives carrying their own prime movers. The advantages of the electric drive have been so well demonstrated and accepted by the railroads that its position now seems invulnerable to the possible vicissitudes in the fortunes of the various prime movers.

In addition to motive power, the many auxiliary services of the railroads are becoming more dependent upon electricity. These services utilize practically every type of electric apparatus for they cover telephone, telegraph and radio communication, signaling, air conditioning, lighting, material handling, terminal operations, and even the generation of power. It has been estimated that present use of electric equipment in land transportation exceeds 25 million horsepower. But of even greater significance is the unprecedented rate at which the use of such equipment is expanding. With an uninterrupted continuation of this trend, the land transportation industry soon will become our recognized leader in the utilization of electric equipment.

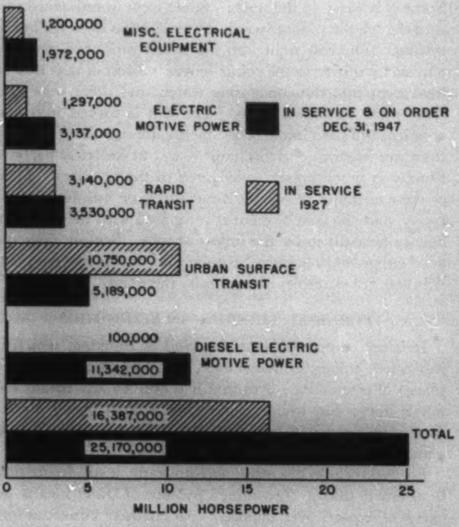

Figure 1. Bar graph indicating the extent to which electric equipment has been adopted by the land transportation industry during the last 20 years in terms of horsepower

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Digest of paper 48-117, "The Increasing Uses for Electricity in Land Transportation," recommended by the AIEE land transportation committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Microwave Molecular Spectroscopy

DONALD K. COLES

Different types of apparatus and methods used in microwave spectroscopy are discussed and various techniques of improving the sensitivity of detection are described.

IT HAS BEEN KNOWN for more than 30 years that very-high-frequency electromagnetic waves would be absorbed by any gas whose molecules possess electric dipoles. The frequencies at which absorption takes place correspond to the rotational frequencies of the molecule. Using war-developed techniques, it is now possible to detect these absorption lines and to measure their frequencies to one part in a million. This provides a proportionally precise measure of the molecular moments of inertia.

By studying the fine structure of rotational absorption lines, one obtains information regarding the spins of the atomic nuclei within the molecule and the charge distribution within the nuclei. The effects of electric and magnetic fields on microwave absorption lines have been examined. A study of these effects makes possible a determination of the electric and magnetic dipoles* associated with the molecule and the magnetic dipoles associated with the atomic nuclei.

The rather definite frequencies at which resonant absorption takes place correspond to the quantised rotational frequencies of the particular molecule. For symmetric-top molecules which have two equal moments of inertia, the absorption frequencies are given by

$$f=\frac{n}{I}\,\frac{h}{4\pi^2}$$

where n is any positive integer, h is Planck's constant, and I is the moment of inertia of the molecule about an axis through the center of gravity and perpendicular to the molecular symmetry axis. For unsymmetrical molecules the wave lengths at which absorption occurs depend in a rather complicated way on the three different moments of inertia of the molecule. For molecules of reasonable size, which will possess absorption lines strong enough to be observed, the molecular rotation region extends from a wave length of about one foot down to a wave length of 0.02 millimeter.

Up to the time of World War II nearly all spectroscopic investigations in the molecular rotational region utilized an incandescent solid as a source of radiation. This was passed through the gas to be studied and the transmitted radiation was analyzed by means of an infrared spectrograph. One narrow wave length region at a time was isolated by means of a diffraction grating and auxiliary filters, and the radiation at that wave length was measured by means of some temperature-sensitive device such as a bolometer or thermopile.

An early attempt to use electronic oscillators as sources in molecular spectroscopy was made in 1933 at the University of Michigan, Ann Arbor, Mich. Here a strong infrared program on molecular rotation spectra was being pushed ahead, including an infrared study of the pure rotational spectrum of ammonia by N. Wright and H. M. Randall. The interpretation of the quite unusual infrared spectrum of ammonia, as made by D. M. Dennison, suggested that this unique molecule also should exhibit a strong absorption at the long-wave-length end of the rotational region. Absorption on this long wave length could be detected only by using an electronic source of electromagnetic waves. Accordingly, in 1933, C. E. Cleeton and N. H. Williams designed and built a set of magnetron oscillator tubes covering the region 1.06 to 3.8 centimeters.[1] They were patterned after some 9-centimeter oscillators loaned by I. E. Mouromtseff of the Westinghouse Research Laboratories, East Pittsburgh, Pa. Radiation from one of these sources was passed through 40 centimeters of ammonia gas at atmospheric pressure and then was analyzed by means of a large diffraction grating and a crystal detector. Cleeton and Williams succeeded in proving that ammonia indeed did exhibit a broad absorption band in the neighborhood of 1.25-centimeter wave length. In 1939 this work at the University of Michigan was continued by H. S. Howe. Constructing his own tubes, a crude wave guide, and wave meter, Howe studied the ammonia absorption at reduced pressures. At the lowest pressure, of one-quarter atmosphere, the line had become much narrower.

Then came World War II during which the concentrated effort of hundreds of physicists and radio engineers was directed toward the production and propagation of very-high-frequency radiation. By the end of the war the production and detection of microwaves as short as 1.25 centimeters had become standard engineering practice. Molecular spectroscopists were itching to try out the new techniques with the very long (to them) infrared waves.

APPARATUS FOR DETECTING ABSORPTION LINES

The first sharp-line absorption spectrum was obtained by B. Bleaney and R. P. Penrose[2] at Oxford University, England.

These investigators introduced ammonia into a resonant cavity, which effectively is a short length of wave guide in which the radiation is reflected back and forth hundreds of times. The effect of the ammonia gas was to damp out the waves and thus to reduce the energy density in the cavity. The change in energy density could be measured by means of a crystal detector.

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* The change of energy of a molecule when placed in a uniform electric or magnetic field is equal to the scalar product of the field and the molecular dipole moment.

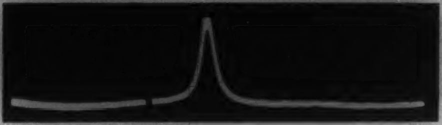

Figure 1. Microwave absorption line

This method of reflecting the microwaves back and forth many times has many obvious advantages from an absorption intensity standpoint. However, it possesses one disadvantage which may be serious in certain cases. The high-energy density thus built up by the multiple transit of radiation may affect the population of the energy levels in the absorbing gas in such a way that the net absorption seriously is reduced. This effect is particularly noticeable at low gas pressures.

Bleaney and Penrose found that at pressures below one millimeter of mercury the broad absorption band of ammonia consisted of several series of very sharp lines. This was in general agreement with the prediction of Dennison and others at the University of Michigan. Bleaney and Penrose announced these results early in 1946, and at that time similar results already were being obtained by W. E. Good[3] at the Westinghouse Laboratories and C. H. Townes[4] at the Bell Telephone Laboratories, New York, N. Y.

The American investigators were using a frequency sweep method which presented a small part of the absorption spectrum on the screen of a cathode-ray oscilloscope at any one instant of time (Figure 1). One form of the apparatus used by Good is shown in Figure 2. The microwaves traversed two meters of ammonia gas and then were detected by means of a silicon crystal. The received signal was amplified and applied to the vertical plates of an oscilloscope. The saw tooth voltage which served for the horizontal deflection of the oscilloscope also was used to vary the frequency of the oscillator, so that the horizontal axis of the oscilloscope became a frequency axis.

The absorption wave meter, indicated in Figure 2, is a variable cavity loosely coupled to the wave guide. When the cavity is exactly tuned to the oscillator frequency it extracts a few per cent of the energy from the wave guide. This is detected by means of a dip in the current from the crystal detector. The micrometer screw which varies the size of the cavity is calibrated in megacycles. The absorbing gas is confined to its section of wave guide by means of thin mica windows which are cemented across the ends of the wave guide. This type of apparatus has sufficed to detect and study the rotational absorption lines of perhaps a dozen simple molecules in the wave length region between 5 and 18 millimeters.

For wave lengths between 11 and 18 millimeters the rectangular wave guide commonly used has external dimensions 1/4 by 1/2 inch with 0.040-inch walls. It commonly is fabricated of high conductivity copper or a high copper brass. In special cases the wave guide is fabricated from silver to reduce its attenuation. In order to detect very weak absorption lines the absorption cell is sometimes made as long as 100 feet. Greater lengths than this do not appear to be practical with a wave guide of this cross section because of the attenuation introduced. One method of reducing the attenuation in a long absorption cell is to use a wave guide of larger cross section which attenuates less strongly. A wave guide of large cross section also allows the transmission of more power to the crystal without disturbing the population of the rotational energy levels in the gas.

One disadvantage of using a large wave guide is that the 5-millimeter microwaves have several different modes of propagation. Moreover, if one is not careful, some of the energy may not be absorbed by the crystal at the far end of the wave guide, so that the waves are reflected back and forth inside the large section of the wave guide. In this instance the large section of the wave guide behaves like an absorption wave meter, and even without an absorbing gas present, one finds a "virtual absorption" spectrum consisting of a large number of sharp absorption lines. When an absorbing gas is present, its absorption lines are confused with those resulting from the apparatus.

Even if a small wave guide is used, in which only one mode of propagation is possible, a fraction of the microwave train is reflected from the crystal end back to the oscillator end, and then forward again with the main train. This twice reflected portion is several hundred wave lengths behind its proper place in the main train. Its phase relationship with the main train will depend on the wave length. Certain wave lengths will be in phase, other wave lengths will be 180 degrees out of phase, and intervening wave lengths will be added to the main wave-train in intermediate phase relationships. The result is that the absorption spectrum resulting from the gas is overlaid by a series of broad bands which may be much stronger than the gaseous absorption lines. This effect is illustrated in *A* of Figure 3. This hilly background partially may be eliminated by comparing the absorption with and without the gas in the wave guide. Complications are introduced, however, by the shift of the standing wave pattern when the gas is introduced because of its small but finite dielectric constant.

Another way[5] of eliminating the standing wave background in the spectrum is slowly to sweep the microwave frequency through a small range of the spectrum and to use a low-frequency filter between the crystal and the oscilloscope so that the oscilloscope does not respond to the gradual change of voltage over the standing wave pattern, but does respond to the high-frequency components generated by the sharp absorption band as in *B*, Figure 3.

The high frequencies may be accentuated by using a differentiating circuit in the amplifier, in which case the gain is directly proportional to the frequency (*C*, Figure 3). If a second differentiating circuit is included, the oscilloscope trace of the absorption line is again symmetrical as shown in *E*, Figure 3. The gain of the amplifier for a low-frequency component is then relatively low, being proportional to the square of the frequency. This attenuation of the low frequencies has an additional advantage in eliminating the low-frequency crystal noise.

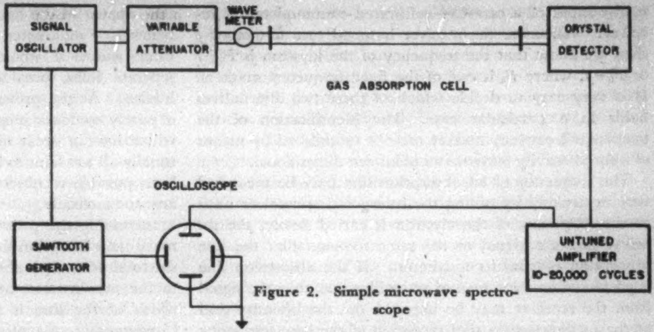

Figure 2. Simple microwave spectroscope

Crystal noise imposes a fundamental limit on the sensitivity of detection of weak absorption lines, unless one builds a microwave-frequency bridge system in which the detecting crystal receives only a small microwave signal. When the main crystal current is at zero frequency, the noise generated in the crystal is greatest at very low frequencies and seems to fall off inversely with the frequency up to the megacycle frequency range. One may take advantage of this situation by frequency modulating the reflex oscillator by means of a small sinusoidal voltage applied to the reflector. The absorption line then acts as a discriminator, producing amplitude modulation of the transmitted radiation at the same frequency. The crystal current then may be amplified by means of a sharply tuned amplifier. If the modulating frequency is 100,000 cycles per second, and the band width is 100 cycles per second or less, the signal-to-noise ratio will be much higher than can be obtained by the method first described. This method of detection has been described by W. D. Hershberger and by W. Gordy and M. Kessler.[6] If the variation of the oscillator frequency from its mean value is small compared with the width of the absorption line, the appearance of the absorption line will be as in *D*, Figure 3. If a phase sensitive amplifier is used, together with a low-frequency filter, the appearance is similar to that in *C*, Figure 3. The true absorption line contour then may be approximated by using an integrating circuit, or, if a differentiating circuit is used instead, a symmetrical pattern may be obtained which represents approximately the second derivative of the true line shape (*E*, Figure 3).

Instead of modulating the oscillator frequency at 100 kc it is possible to obtain almost the same results by modulating the absorption line frequency by means of a high-frequency electric or magnetic field applied to the gas. Modulation of the absorption lines has the additional advantage of almost eliminating spurious effects such as the standing wave pattern. The method of modulating the absorption line frequency by means of an electric field has been described by R. H. Hughes and E. B. Wilson,[7] and up to the present time it has proved the most successful method for searching a large region for weak absorption lines.

It is possible to reduce the crystal noise greatly, and incidentally, any noise originating in the source, by using a microwave-frequency bridge. In this method power from the microwave source is divided into two transmission paths, then recombined before detection. The gas to be studied is introduced into a wave guide section forming one branch of the bridge and the bridge unbalance is used as the detection signal. The reduction in amount of microwave power reaching the crystal results in a great improvement in signal-to-noise ratio. Consequently, to get a very strong signal, it is advantageous to transmit larger amounts of microwave power through the absorption cell. Microwave spectroscopes of this type, and using superheterodyne receivers, have been constructed at the Massachusetts Institute of Technology, Cambridge, Mass., and at the Bell Telephone Laboratories.

FREQUENCY MEASUREMENTS

For frequency measurements accurate to one part in 5,000, the absorption wave meter described previously is very simple and convenient to operate. Larger cavity wave meters have been used for measurements accurate to one part in 50,000. In these wave meters a number of different modes of oscillation are possible for each adjustment of the cavity parameter. By varying this parameter one of the absorbed frequencies may be brought into coincidence with a gaseous absorption line. The problem then arises of identifying the particular mode of oscillation, and of calibrating each absorbed frequency against the cavity parameter.

A convenient basis for precision frequency measurements is a quartz crystal oscillating at 1 or 5 megacycles. By a process of frequency doubling and tripling, using high-frequency triodes, this frequency may be multiplied up to about 500 megacycles. The output of the final triode stage then is impressed on a crystal which generates harmonics extending throughout the microwave region. The frequency doubling apparatus in use at the Westinghouse laboratory, which was built by W. E. Good and J. Wood, ends up at a frequency of 480 megacycles. The high harmonics of this frequency constitute a series of fixed frequency markers spaced 480 megacycles apart. If markers closer together than this are required, it is possible to mix in other multiples of 5 megacycles, using the 480 harmonics as carriers. While the wave meter is being calibrated the 5-megacycle crystal is zero beat against the National Bureau of Standards station *WWV* in Washington, D. C.

Absorption line frequencies can be measured much more accurately by using a communications receiver to pick up the beat notes between the signal oscillator of the microwave spectroscope and the fixed frequency markers. For this purpose a fraction of the klystron output is extracted and mixed in a crystal with the fixed frequency markers. The difference frequency generated in the crystal is applied to the input of a carefully calibrated communications receiver. Whenever the receiver is tuned to a frequency f then we know that the frequency of the klystron is F_0+f or F_0-f, where F_0 is one of the fixed frequency markers. It is very easy to decide which of these two alternatives holds in a particular case. The identification of the particular frequency marker may be established by means of a simple cavity wave meter of known dimensions.

The frequency of an absorption line may be measured very accurately by tuning the interpolating receiver until as the frequency of the klystron is varied slowly, the receiver passes a signal at the same moment that the line absorption reaches its maximum. If the absorption line is presented on the screen of an oscilloscope, then the signal from the receiver may be imposed on the intensity grid of the oscilloscope so that reception of the beat frequency is indicated by a bright spot or a blank spot on the oscilloscope trace. Such a blank spot is shown in the trace of Figure 1. An absorption line frequency then is measured by tuning the receiver until the blank spot appears at the peak of the absorption line.

When measurements are being made on sharp absorption lines, it is possible to reproduce settings of the communications receiver to 10 kc. As the receiver easily can be calibrated to this accuracy (at least in the low-frequency bands) it is possible to measure absorption line frequencies to better than one part in a million.

EXPERIMENTAL RESULTS

Microwave absorption lines have been found for about 50 different gases. A majority of the molecules studied so far belong to the special class of "symmetric-top" molecules, which possess a relatively simple absorption spectrum (Figure 4*A*). The four absorption lines shown solid in this figure actually have been observed, while the one line shown dotted has not been observed so far. The reason that this line has not been observed is that it falls in the gap between the radar *X*-band and the *K*-band, where oscillators are not generally available. It is very much to be hoped that oscillators soon will be available to cover this interesting region between 10,000 and 20,000 megacycles.

The spectrum shown in Figure 4*A* is that of carbon-oxysulfide (COS). The three atoms in this molecule lie on a straight line. Another example of the class of symmetric-top molecules is methyl chloride, (CH_3Cl), in which three hydrogen atoms are disposed symmetrically about an axis of symmetry, while a carbon and a chlorine atom lie on the axis of symmetry. This molecule has a series of absorption bands spaced uniformly 26,000 megacycles apart.

The great majority of molecules do not possess such axes of symmetry, and their lines are spaced irregularly as in Figure 4*B*. This spectrum corresponds to a medium weight molecule such as ClO_2 at a low temperature. At higher temperatures the spectrum would be more complicated, but individual absorption lines would be less intense. Heavier, many atomic molecules will have a spectrum still more complicated, but the individual lines will be extremely faint.

The absorption lines may be made much narrower than they appear in the figure by pumping the gas to pressures below 10^{-1} millimeter of mercury. Thus in the frequency range shown it would be possible to resolve a million separate lines, provided that they were all sufficiently intense. At the present time, however, this statement is of purely academic interest. In the case of heavy molecules which have a great many absorption lines, the lines are usually all too faint to be detected. At this date it has not been possible to observe as many as a hundred lines for any one molecule.

Increasing the pressure of the gas does not necessarily make the absorption lines easier to detect. It is true that the total area of an absorption line is directly proportional to the pressure but over a large range of pressures, the width of the line is also proportional to the pressure. Consequently, the absorption coefficient at the peak of the absorption line tends to assume a constant value, independent of pressure.

In the case of the asymmetric-top molecule SO_2, more than 30 lines have been observed. These have provided sufficient information to determine the three moments of inertia of the SO_2 molecule at low rotational speeds.

The absorption spectrum of SO_2 has not been completely interpreted. There is difficulty in assigning observed absorption lines to transitions between the higher rotational levels, because of the fact that the molecule can be treated only very roughly as a rigid body. In the higher rotational levels the moments of inertia of the molecule are affected greatly by centrifugal distortion. Some of the fainter lines that have been observed may result from the

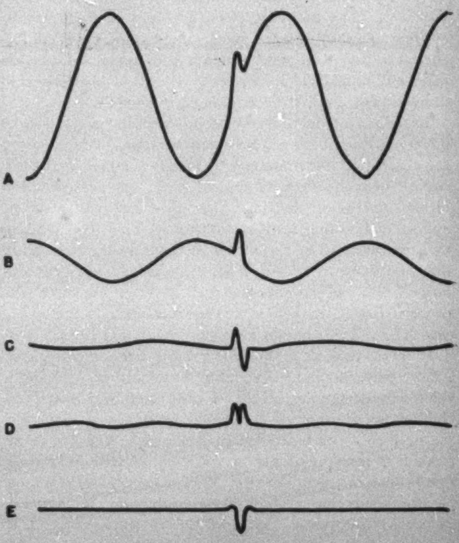

Figure 3. Elimination of standing wave pattern from absorption spectrum

vibrating SO_2 molecule, or to SO_2 molecules containing different isotopes of sulfur.

In the case of carbon-oxy-sulfide, faint lines are found resulting from the less abundant isotopes of sulfur. Lines have been found which are due to $_{16}S^{34}$, which is naturally present in a concentration of 3 per cent, and faint lines are found due to $_{16}S^{33}$, which is naturally present in a concentration of only 1 per cent. Absorption lines associated with these isotopes are shifted several hundred megacycles toward lower frequencies, corresponding to the increased moment of inertia. Because the two interatomic distances in the molecule are almost unaffected by the change in isotopic mass, a measurement of the isotope shift tells how far that particular isotope is from the center of mass of the molecule. In the case of a simple molecule like C-O-S, this information is sufficient to fix the two bond distances in the molecule.

So far only rotational energy of the molecule resulting from the orbital motion of the atoms about the molecular center of mass has been discussed. In many cases, however, the atomic nuclei themselves possess an interna angular momentum or spin. If there exists any coupling between the nuclear spin and the orbital motion of the molecule, the orbital angular momentum no longer will be a constant vector, but will precess slowly about a fixed axis of total (nuclear plus rotational) angular momentum. Because the nuclear spin may be oriented at several different angles with respect to the rest of the molecule, the average interaction energy may assume several different values, and a rotational level becomes a close multiplet.

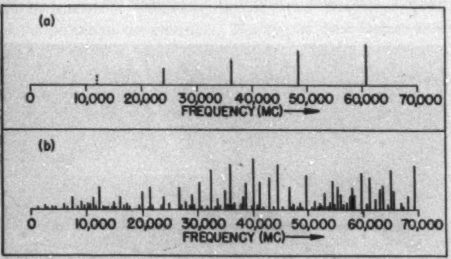

Figure 4. Microwave absorption spectra

A—Symmetric-top molecule *B—Asymmetric-top molecule*

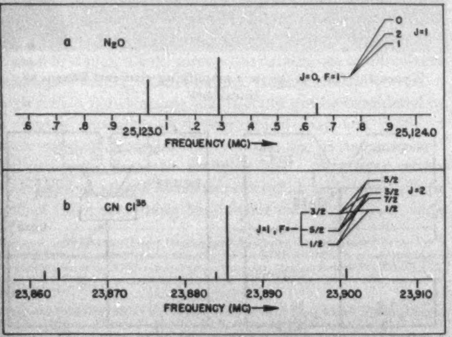

Figure 5

A—Hyperfine structure for the $J=0$ to $J=1$ rotational transition of nitrous oxide
B—Hyperfine structure for the $J=1$ to $J=2$ transition of cyanogen chloride

For a nuclear spin of one, the rotational levels become triplets, except for the level corresponding to $J=0$, which remains a singlet. Thus the absorption line corresponding to the transition $J=0$ to $J=1$ becomes a triplet. An absorption line corresponding to such a transition in N_2O is shown in Figure 5*A*.

For a nuclear spin of 3/2, the rotational lines become quartets in general. By studying the absorption spectrum of CNCl it has been possible to establish definitely[8] that the two chlorine nuclei have spins of 3/2, whereas they formerly were believed to have spins of 5/2. The multiplet corresponding to the rotational transition $J=1$ to $J=2$ of CNCl is shown in Figure 5*B*.

The interaction energy observed here does not result from a magnetic coupling between the nucleus and the magnetic field of the molecule, but is a considerably larger interaction between the electric field gradient of the molecule and the electric quadrupole moment of the nucleus. This shifting of a rotational energy level roughly may be considered as a rotational frequency shift resulting from the precession of the axis of molecular rotation which, in turn, is caused by the pull of the nucleus.

As the molecules possess an electric dipole moment, an electric field applied to the gas affects the energy of the molecules. This phenomenon, called the Stark effect, depends on the orientation of the orbital angular momentum vector with respect to the electric field. In general several different angles of orientation are possible. Thus a rotational energy level is broken up into a multiplet, and so is an absorption line. In certain cases the shift in frequency is very large, and proportional to the strength of the electric field. Generally the first order Stark effect is zero, and one observes a smaller, second order Stark effect. As this effect depends on the speed and state of rotation, it is a great aid in identifying an absorption line as being a resultant of transition between particular rotational states. The effect is also an ideal method for measuring the strength of the electric dipole[9] and its orientation with respect to the inertial axes of the molecule.

Most molecules contain an even number of electrons so that they do not possess a magnetic moment, unless the molecule as a whole is rotating. A weak magnetic moment is generated by the orbital motion of the atoms, being directly proportional to the speed of rotation. When a magnetic field is imposed on such a molecule, it interacts with the field and an absorption line splits up into a multiplet. In this case as in the electrical analogue, the effect on the absorption line depends on the orientation of the microwave electric vector to the external magnetic or electric field. For linear molecules the simple "Zeeman" effect is observed, with polarization of the microwaves exactly as predicted by H. A. Lorentz in 1898. In other rotational transitions a complex Zeeman effect is observed. If there is a coupling between the molecule and one of its atomic nuclei, it is possible to deduce the magnetic moment of that nucleus.

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The Transistor—A New Amplifier

A new type of amplifying element known as a "transistor" which promises to have far reaching significance in electronics and electrical communication was demonstrated recently before members of the press by the Bell Telephone Laboratories, Inc., New York, N. Y. Like a vacuum tube, the transistor can serve as an amplifier or as an oscillator, yet it contains no vacuum, glass envelope, grid, plate, or cathode.

Two point contacts of the "cat's whisker" or detector type are made to a semiconductor (germanium was used in the samples demonstrated) 0.002 inch apart. The entire apparatus is housed in a small metal cylinder less than an inch long (see Figure 1). The unit has been shown to produce amplification as high as 100 to 1 (20 decibels), and some test models have been operated as amplifiers at frequencies up to ten megacycles.

A number of interesting applications for the transistor were presented. In one demonstration it was used to amplify audio frequencies traveling between two telephones. In another, a tubeless radio receiver using transistors as amplifiers, and a point contact rectifier for a detector, was operated satisfactorily. A transistor also was used to generate a standard frequency tone, thus demonstrating its capability as an oscillator.

The transistor is said to be little affected by ordinary changes in temperature (minus 50 to plus 50 degrees centigrade), and such characteristics as life, ruggedness, and stability are expected to be much the same as those of point contact rectifiers though no data are available at the present time. Because the device is still in the experimental stage no data on cost are available either.

Electrically, the transistor differs somewhat from the ordinary vacuum tube. The input impedance is low (about 1,000 ohms) and the output impedance is high (about 10,000 ohms). The power handling capability of the units demonstrated was 50 milliwatts, and the power consumption is about 0.1 watt. Figure 2 indicates a typical amplifier and oscillator circuit using the transistor.

The amplification process in the transistor is caused by the fact that the input contact (called the "emitter") is surrounded by an "area of interaction." Within this area the electronic structure of the semiconductor is modified by the input current. If the output contact (called the "collector") is placed in this area, the output current can be controlled by the input current thus producing the basic mechanism of amplification.

While many scientists have been associated with the work during the project, key investigations were carried out by Doctor John Bardeen and Doctor Walter H. Brattain. The general research program which led to the development of the transistor was initiated and directed by Doctor William Shockley. All three are members of the Bell Telephone Laboratories technical staff.

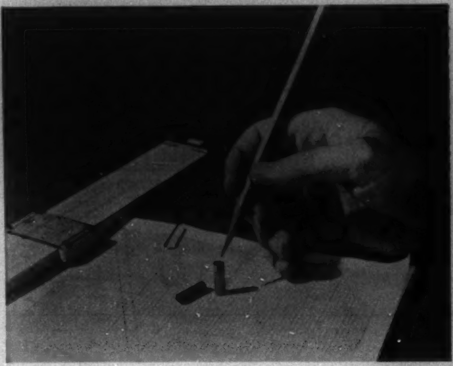

Figure 1. Two of the new amplifying elements known as transistors

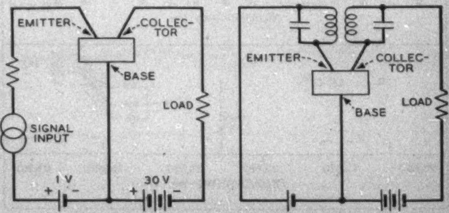

Figure 2. Two circuits using transistors

At the left is a typical amplifier circuit, and at the right is a typical oscillator circuit

Power Development in Mexico

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THE MEXICO SECTION of the AIEE at its District meeting held in San Antonio April 1946, presented a paper* analyzing the estimated requirements to supply the increasing demand of power in Mexico up to the end of 1949. It was explained then that it was urgent to increase the installed generating capacity by 53 per cent within the next four years and that new generating plants with a total capacity of 400,000 kw were required. As the installed capacity in 1945 was 756,000 kw, a total capacity of 1,156,000 kw should be available by the end of 1950.

The results actually obtained in the last two years up to the end of 1947 show that the forecast made for 1947 was on the high side, as actual generation during that year was 3,598,000,000 kilowatt-hours whereas it was estimated that approximately 300,000,000 kilowatt-hours more would be generated. Two of the causes for this reduced generation were delays in delivery of power equipment from the United States and a shortage of water in 1947 which affected the hydroelectric systems supplying more than 80 per cent of the power in the country. Because of these factors and others, the use of power was restricted in many instances to 50 per cent of normal consumption. If the forecast on generation was high for 1947, the installed capacity estimated for that year was surpassed. However the greater part of this additional capacity was put into service during December, which explains why there was not a proportional increase of generation during that year. New plants are in process of construction and 359,900 kw in additional generating capacity will be available within three years. Power plants now under construction are listed in Table I.

Because 27.5 per cent of Mexico's population is concentrated in cities of 5,000 or more inhabitants and because rural centers offer no incentive to private utilities, the Federal Electric Commission has embarked on a vast program of rural electrification. To illustrate how this program has been planned, a brief description of the work being done in the state of Veracruz may be of interest.

As a first step, a field survey was carried out of all villages with more than 1,500 inhabitants lacking electric service or with such a deficient one that it could not be considered as a "public service." A topographical map was made of each village, classifying every house by its category and indicating for each the probable load. A similar census was taken of all the industries operating with small plants and of those now using hand labor exclusively but which could be electrified. In this way, a fair estimation of the requirements of each village and of its surrounding agricultural district was made.

After spotting these villages on a map of the state, those relatively close to each other were grouped together to form small isolated systems, each to be provided with a Diesel power plant and the necessary rural-type distribution lines. The villages were grouped in such a way that later on, depending on the power facilities and the demand, some of the groups can be interconnected to make larger systems until a stage is reached when the erection of transmission lines joining together all these groups becomes justifiable from an economical standpoint. Every time that two or more of the initial small groups are interconnected, a larger plant will be provided to feed the larger system thereby gradually reducing the number of small plants.

A standard type of power plant has been selected for the initial steps of the program, consisting of Diesel units of from 100 to 300 kw. Each plant will have a complete spare generating unit. When selecting the equipment, special attention was given towards standardization, not only for different units of the same plant but also for the various plants that may be installed all over the country. This will permit reducing to a minimum the investment in spare parts, giving at the same time more flexibility to the use of such parts and a more ready and reliable maintenance. Another advantage of this standardization is that the operating and maintenance personnel will have to get acquainted with only one type of equipment and gradually will acquire a higher degree of specialization.

In the state of Veracruz, selected as an illustration of this program, 76 villages with a total population of 166,000 inhabitants have been grouped into 36 small systems, each to be provided with a power plant of 200 to 900 kw; the total plant capacity to be installed is 14,400 kw.

Table I. Mexican Power Plants Under Construction

	Capacity in Kilowatts	
	Thermoelectric	Hydroelectric
Sta. Bárbara, Mexico		63,600
Racubaya, Federal District	30,900	
Extension to Lerma, Michoacán		27,600
Colimilla, Jalisco		25,600
La Laguna, Durango	25,000	
Guaymas, Sonora	25,000	
El Durazno, Mexico		16,400
Extension to Mecaxa, Puebla		16,000
Extension to Bella Vista, Nuevo León	15,000	
Monclova, Coahuila	10,000	
Ciudad Juárez, Chihuahua	15,000	
Guadalajara, Jalisco	10,000	
Ciudad Obregón, Sonora	15,000	
El Encanto, Veracruz		10,000
Minas, Veracruz		9,600
Celaya, Guanajuato	7,500	
Puebla, Puebla	7,500	
San Luis Potosí, S.L.P.	7,500	
Other small plants	13,500	9,200
Totals	181,900	178,000
Grand total	359,900 kw	

Digest of paper 48-158, "Power Development in Mexico," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67 1948.

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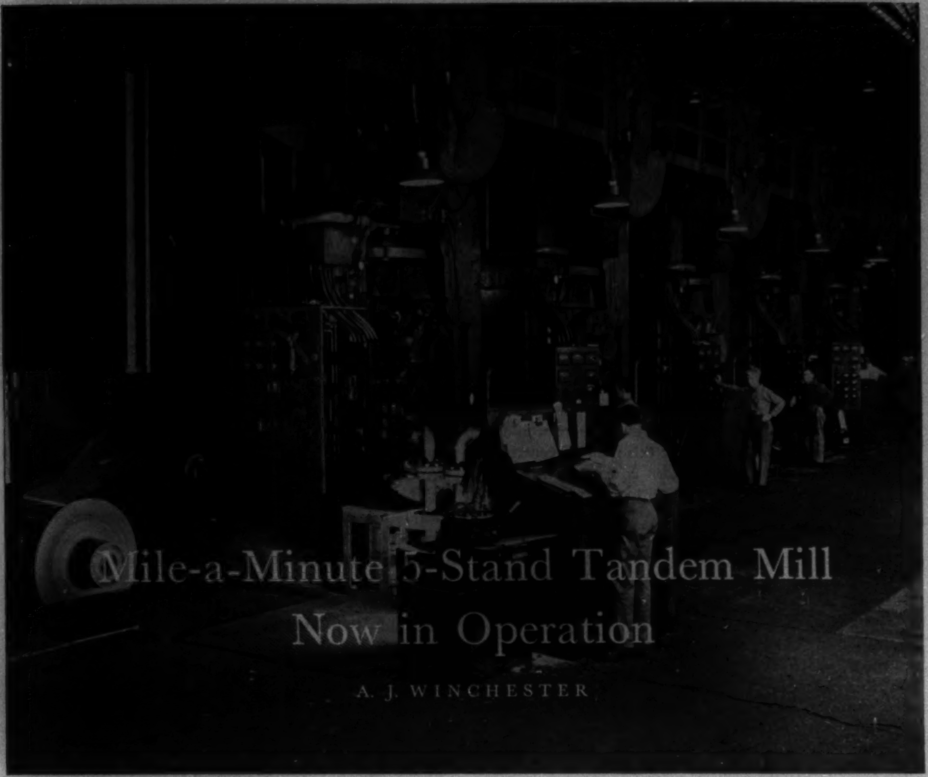
*The paper referred to is "Mexico's Electrification Program," by Basil Nikiforoff, Alejandro Paez Urquidi, Alfonso Fernandez del Busto, and Oscar R. Enriquez, which appeared in *ELECTRICAL ENGINEERING* (*part I—EE, May '46, pages 193–7; part II—EE, June '46, pages 245–51*).



Mile-a-Minute 5-Stand Tandem Mill Now in Operation

A. J. WINCHESTER

DELIVERY SPEED of a mile-a-minute on a tandem cold mill is no longer a steel industry dream for in May 1947 one of the fastest and the most powerful tin-plate tandem cold reduction mills in the world was placed in operation at the Weirton Steel Company, Weirton, W. Va. Capable of rolling steel at a top speed of more than 5,000-feet per minute, this mill marks a major development in the cold reduction process of rolling steel. Total capacity of the mill and reel motors is 17,550 horsepower, the largest amount of power ever concentrated in one tin-plate tandem mill.

While primarily designed for rolling light gauge strip for tin plate, the mill also can roll heavier gauge material up to about 0.025 inch thick. Tin plate rolled ranges from 0.006 to 0.015 inch thick and up to 38 inches wide. The reel winds coils weighing more than 30,000 pounds with $16^{1}/_{2}$-inches inside diameter and up to 66 inches outside diameter.

A 375,000-cubic-feet-per-minute electrostatic air cleaner cleans the air used for forced ventilation. Three 42,000-cubic-feet-per-minute fans deliver air to the mill and reel motors in the mill building. Three 60,000-cubic-feet-per-minute fans deliver air to the main motor generator sets in the main mill building and to the basement control room in which are located the auxiliary booster and exciter motor generator sets, main drive and auxiliary control equipment, 6,600-volt switchgear, and 1,000-kilovolt-ampere unit substation for 550-volt auxiliary power.

In tandem rolling of strip steel, the strip is threaded into the mill at low speed, usually about ten per cent of top speed. When the steel is all the way through the mill and wrapped on the reel, the mill is accelerated to a preset rolling speed.

Figure 1 is a schematic diagram of the main circuits. Ratings of the motors and generators are as follows:

Stand *1*—1,750-horsepower 750-volt 70–210-rpm single-armature motor, direct-coupled to the mill pinion stand.

Stand *2*—3,500-horsepower 750-volt 125–312.5-rpm single-armature motor, direct-coupled to the mill pinion stand.

Stand *3*—3,500-horsepower 750-volt 225–450-rpm double-armature motor, direct-coupled to the mill pinion stand.

Stand *4*—Two 1,750-horsepower 750-volt 225–450-rpm single-armature motors, comprising a 3,500-horsepower twin-motor for separate

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drive of the upper and lower work rolls through 1.55-to-1 ratio step-up gearing.

Stand 5—Two 2,250-horsepower 750-volt 250–450-rpm single-armature motors, comprising a 4,500-horsepower twin-motor for separate drive of the upper and lower work rolls through 2.0-to-1 ratio step-up gearing.

Winding Reel—800-horsepower 750-volt 300–1,100-rpm double-armature motor, direct coupled to the reel shaft.

Generators—Four 3,500-kw 720-volt 360-rpm generators. There are two sets with two generators on each set. Each set is driven by 9,900-horsepower 6,600-volt 60-cycle synchronous motor.

MAIN BUS VOLTAGE CONTROL

Four generators in parallel supply a common bus that feeds all five stand motors and the reel motor. The mill is accelerated and decelerated by raising and lowering the bus voltage. To obtain the proper speed ratio between stands, the speed of each stand is adjusted by field control with the mill running idle at a constant voltage.

Each of the four main generators has a differential and a cumulative series field. These fields are cross-connected to insure equal division of load.

Generator voltage is controlled by a Rototrol rotating regulator. The generator fields are connected in series and fed from an exciter. A motor-operated rheostat varies current in the exciter field and thus generator voltage. The Rototrol armature is connected in series with the exciter field.

For steady state operation, the output of the Rototrol is approximately zero. When the generator voltage is changed, the Rototrol makes the generator voltage follow the rheostat with minimum delay. Without the Rototrol, the generator voltage lags considerably because of circuit time constants. The Rototrol keeps to a minimum the voltage change with load variation.

SPEED CONTROL OF MILL MOTORS

Because the gauge of the steel is determined by tension as well as pressure between the work rolls, it is quite important that the stand speeds remain at the same ratio with respect to each other at all speeds of the mill. This is accomplished by means of *IR* (ohmic drop) boosters and magnetizing exciters. As shown on Figure 1, each mill motor has an *IR* booster in its armature circuit. Each motor has a belt-driven magnetizing exciter.

This 42-inch 5-stand tandem cold reduction tin-plate mill has a maximum delivery speed of more than 5,000 feet per minute. The design, operation, co-ordination, and control of the electric driving equipment illustrates the intricacies of recent developments in the field of heavy machinery.

Speed change of a d-c motor because of load variation is caused by two things; voltage drop in the armature circuit and distortion of the flux. Motor speed is directly proportional to counter electromotive force and inversely proportional to flux.

$$RPM = K\frac{E}{\phi}$$

Counter electromotive force is given by the equation, $E = V - IR$, where E is counter electromotive force, V is bus voltage, and IR is voltage drop in armature circuit.

If counter electromotive force were the only factor that determined speed change with load variation, speed would drop in a straight line relation with increasing load as shown by the two equations given in the previous paragraph. Speed drop resulting from *IR* drop at 100 per cent load with constant field current is the same regardless of no load speed where the change in no load speed is accomplished by varying line voltage.

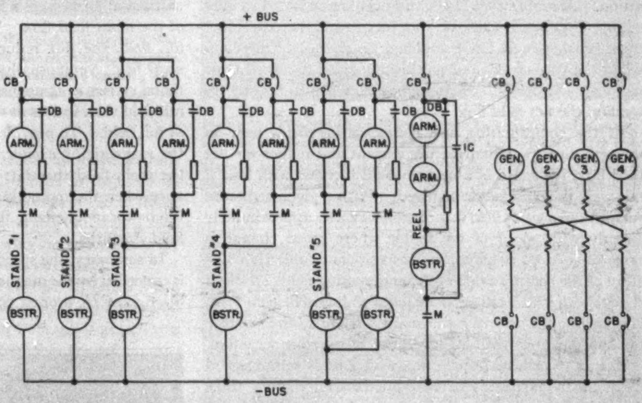

Figure 1. Schematic diagram of main circuits

CB—Cicruit breaker
DB—Dynamic braking contactor
IC—Inching contactor
M—Line contactor
BSTR—IR booster

The *IR* booster in each motor armature circuit compensates for the change in counter electromotive force with change in load. Each *IR* booster is excited from the drop across the interpoles of the motor with which it is in series. The boosters are adjusted so that they produce a voltage which compensates approximately for the *IR* drop.

The Weirton tandem mill motors and those on most modern mills are compensated. A compensated motor has series pole face coils located so that they minimize the distortion of the field flux resulting from armature reaction. These motors also have series commutating coils wound around interpoles lo-

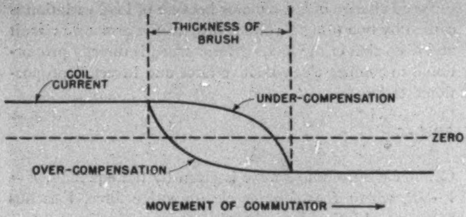

Figure 2. Current in coil undergoing commutation

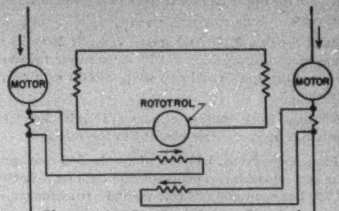

Figure 4. Load balance Rototrol circuit

cated between the main field poles. Most motors commutate best when they are slightly over-compensated. Figure 2 shows how the current in a coil undergoing commutation varies with overcompensation and undercompensation. A motor that is slightly overcompensated usually commutates best because the current in a coil short-circuited by a brush almost has completed its change of direction when the trailing edge of the brush leaves the commutator segment. However, overcompensation tends slightly to weaken the net field flux.

As the commutating and compensating fields vary in strength directly with armature current and reduce the net field flux, the speed of a motor would increase with load if this were the only factor involved. With a given armature current and a given field flux, this effect varies approximately directly with speed of the motor where speed change is accomplished by varying terminal voltage (Table I). The effect of the commutating and compensating fields on speed change with load is not the same for all values of field current. In general, the stronger the main field flux, the smaller the speed change with load because of overcompensation.

The change in main pole flux with load is compensated for by the magnetizing exciter coupled to each motor. Like the *IR* boosters, these machines are excited from the interpole drop. As the magnetizing exciter is coupled mechanically to the motor armature shaft, its output is directly proportional to motor speed as well as load. The output of the magnetizing exciter energizes through a rheostat a magnetizing field on the motor. For a given load on the motor the magnetizing exciter circulates current in this field to compensate for the reduction in main field flux because of overcompensation. The amount of compensation required to account for flux change with load varies with the strength of the main field flux. When the motor is operating with full field, the flux reduction with load is smaller than at weak field; yet it usually takes more output from the magnetizing exciter to compensate for field weakening with load at full field than it does at weak field because of the saturation at full field. To provide for this, the rheostat in series with the magnetizing exciter output is coupled mechanically to the main field rheostat; this rheostat has minimum resistance when the motor is at full field and is tapered so that the motor magnetizing field receives the correct input at all field strengths.

In summary, the speed rise because of overcompensation is cancelled by the magnetizing exciter, while the speed drop because of *IR* drop is compensated for by the *IR* booster.

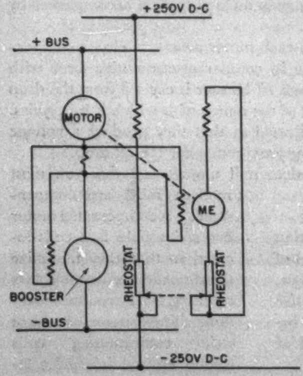

Figure 3. Motor circuit with magnetizing exciter and IR booster

Figure 5. Ventilating air for tandem mill motors and the motor generator sets of the number 6 tandem cold strip mill is cleaned with a Westinghouse Precipitron electrostatic air cleaner

This is a view of the entry side of the 378,000 cubic feet per minute cell bank

Figure 6. These pedestal-mounted Westinghouse-type CHM air circuit breakers control the 750-volt d-c circuits that supply power to the mill and reel motors of the number 6 tandem cold strip mill; they are located in the foundation below the two 7,000-kw main motor generator sets

Because a slightly drooping characteristic is desirable from the standpoint of stability, the *IR* booster is adjusted to compensate for a little less than 100 per cent of the *IR* drop. This gives the motor a slightly drooping characteristic. Figure 3 is a schematic diagram showing the connections for the magnetizing exciter and *IR* booster circuits.

Stands *4* and *5* have twin motor drives. Stand *3* has a double armature motor with the two armatures connected in parallel. On stands *4* and *5*, each work roll is geared to a separate motor. It is quite important that the two motors on each of these stands divide the load. This is accomplished by means of load balance Rototrols.

Figure 4 is a schematic diagram showing how a load balance Rototrol functions. Each twin motor has a load balance field. The two load balance fields are connected in series across the armature of the load balance Rototrol. The fields are connected so that when current is passing in one direction, the field on one machine is cumulative and that on the other is differential. The Rototrol has two shunt fields; one of which is connected across the interpoles of one twin mill motor and the other across the interpoles of the other twin mill motor. With current flowing in the same direction through the armatures of the two mill motors, the two Rototrol fields buck each other. If the motor loads are balanced, the output of the Rototrol is zero. If the load is greater on one motor, the Rototrol produces a voltage that circulates a current through the motor load balance fields; the field of the motor drawing the most load is strengthened and that of the motor taking the least load is weakened. This causes the motors to divide the load equally. Although it takes some difference in load to produce corrective action, this difference is so small it may be neglected.

REEL CONTROL

Tension in the strip between the reel and the fifth stand is controlled by a regulating tensiometer. A roll between the

Figure 7. The 11-unit auxiliary booster and exciter motor generator set in basement control room of the tandem cold strip mill

Magnetic control panels for the tandem mill are at the left. The operator is in front of the duplex meter and control board from which can be observed the performance of all machines making up the tandem mill drive

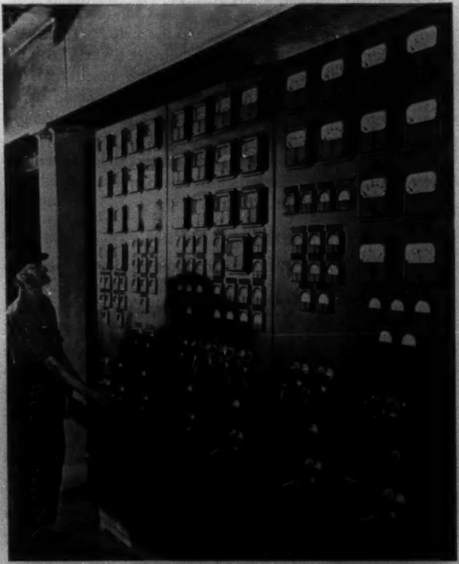

Figure 8. Front of duplex meter and control board in the tandem cold reduction tin plate mill

Indicating meters in the armature and field circuits of every main and auxiliary machine making up the mill drive give the attendant complete supervision of the performance and enable quick location of any abnormal condition

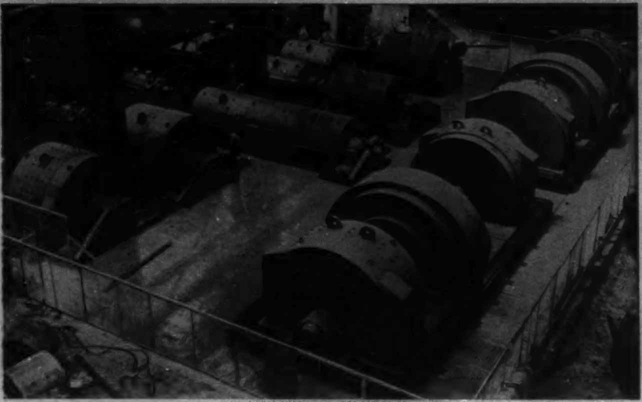

Figure 9. Electric drive equipment for the high speed 42-inch 5-stand tandem cold reduction tin-plate mill

In the right foreground are the two 7,000-kw main motor generator sets, and in the upper left are the mill drive motors (left to right) stand 1, stand 2, stand 3, stand 4, stand 5, and winding reel

fifth stand and reel is forced upwards against the strip by an air cylinder; the roll is connected to the piston of the air cylinder by a mechanical linkage. The regulator holds the speed of the reel motor such that the tensiometer maintains a fixed position, which means that the force from the air cylinder is balanced by tension in the strip. To change strip tension, the pressure in the air cylinder is varied but the tensiometer still regulates for the same position. The tensiometer controls reel motor speed by operating on armature voltage through a series booster and field strength through a motor operated rheostat.

Indicating tensiometers tell the operators the strip tension between all stands. The indicating element is actuated by a roll which rides against the strip.

MILL OPERATION

As shown in Figure 1, there is a circuit breaker between the positive terminal of each motor and generator and the positive common bus. These circuit breakers are pedestal-mounted, electrically operated, air break type, and are all located in one room in the mill basement. Each of the generators also has a circuit breaker in the negative connection to the common bus. Each motor has a magnetically operated line contactor in the connection to the negative bus.

The mill is accelerated to thread speed and run speed and decelerated to thread speed and stop without opening the connections between the motors and generator and the common bus. This is done by raising and lowering bus voltage. The mill speed follows closely and varies uniformly with the position of the master motor operated rheostat which controls generator voltage. The mill decelerates at a uniform rate of speed from full speed to a dead stop.

If any one circuit breaker opens, all line contactors are opened automatically and the mill comes to a stop by dynamic braking. The dynamic braking contactors are interlocked with the line contactors so that dynamic braking is applied on a motor whenever its line contactor is opened.

Table I. Voltage Induced in Coil Undergoing Commutation

Speed Per Cent*	Counter Reactance Voltage From Commutating and Compensating Fields	Reactance Voltage From Current Changing Direction	Net Effect or Difference
100	10	9.7	0.3
10	1	0.97	0.03

* Where speed variation is accomplished by voltage control with constant field current.

Industrial Safety Statistics

According to the National Safety Council, industry had a better safety record in 1947 than in 1946. The "accident frequency rate," for all industries reporting, (number of disabling injuries per 1,000,000 man-hours) was 13.26 in 1947, ten per cent less than in 1946. The "accident severity rate," (number of days lost per 1,000 man-hours) was 1.23 in 1947, seven per cent lower than in 1946. The 1947 injury frequency and severity rates follow:

Industry	Frequency
Communications	2.98
Electric equipment	6.02
Steel	6.08
Tobacco	6.55
Aircraft manufacturing	7.14
Cement	7.23
Railroad equipment	8.08
Textile	8.83
Chemical	8.86
Rubber	9.04
Miscellaneous manufacturing	9.35
Wholesale and retail trade	9.57
Automobile	10.06
Glass	10.95
Printing and publishing	11.02
Service	11.26
Sheet metal	12.86
Iron and steel products	13.01
Petroleum	13.16
ALL INDUSTRIES	13.26
Nonferrous metals and products	13.94
Machinery	14.48
Shipbuilding	15.31
Electrical utilities	15.41
Air transport	16.30
Leather	16.77
Quarry	17.05
Storage and warehousing	17.45
Pulp and paper	18.32
Food	20.45
Gas utilities	22.05
Meat packing	22.19
Construction	24.14
Clay products	24.16
Foundry	25.07
Transit	26.19
Marine transport	29.89
Woodworking	30.19
Mining, other than coal	50.54
Mining, coal	54.46
Lumbering	59.74

Industry	Severity
Communications	0.16
Wholesale and retail trade	0.17
Service	0.21
Tobacco	0.24
Leather	0.32
Aircraft manufacturing	0.41
Electric equipment	0.45
Miscellaneous manufacturing	0.50
Textile	0.54
Printing and publishing	0.64
Automobile	0.66
Glass	0.66
Rubber	0.70
Meat packing	0.75
Iron and steel products	0.81
Machinery	0.82
Chemical	0.92
Storage and warehousing	0.98
Sheet metal	1.04
Railroad equipment	1.11
Food	1.16
ALL INDUSTRIES	1.23
Gas utilities	1.25
Petroleum	1.33
Foundry	1.35
Transit	1.37
Pulp and paper	1.39
Non-ferrous metals and products	1.49
Steel	1.60
Clay products	1.85
Woodworking	1.98
Air transport	2.12
Shipbuilding	2.18
Electrical utilities	2.39
Construction	2.64
Marine transport	2.81
Cement	2.82
Quarry	3.69
Lumbering	5.24
Mining, other than coal	6.17
Mining, coal	7.96

Economic Aspects of Radio-Frequency Heating

LAWRENCE M. DURYEE
MEMBER AIEE

THE IMPORTANCE of industrial applications of radio-frequency heating is emphasized by the growth of this field which has expanded into a business with an eight million dollar annual volume. Thus, an economic analysis of some of the problems including cost data in specific industries is of interest.

So confused have the terms become, as increasing frequency bands became available to industry, that the designation of band numbers utilizing the power of ten as the basis as shown in Table I has been suggested. This proposal has been made by the AIEE subcommittee on electronic heating of the committee on electric heating.

A mathematical analysis of total equipment costs including capacitors where they are economically justified is indicated in the following equation:

$$\text{Total Cost} = \frac{W\left(A + C\sqrt{1-(PF)^2}\right)}{PF}$$

where W is power output in kilowatts; A is generator cost in dollars per kilovolt-amperes; C is capacitor cost dollars per kilovolt-amperes; and PF is the power factor of the load circuit.

Analysis also indicates the need for work-coil diameter in induction heating approaching as closely as possible the diameter of the product to obtain maximum efficiency.

Specific case histories of induction heating in industry show a wide range of products including items which cannot be processed by other heating methods. Notable in this class is the brazing of Alnico to steel at 1,200 degrees Fahrenheit without harming the magnetic properties of Alnico. An example of economic justification for induction heating is the manufacturer (Mitchell and Unsinn Company, Washington, D. C.) who produced hatchet-heads tempered automatically by induction heating (operating in band number 5) at a cost of $1.38 per hour as compared with $3.79 per hour using flame-tempering. A comparison of the economics of the two methods is shown in the following:

Former Method	
Fuel	$0.90
Labor of two men to operate machine	1.90
Labor of one man to clean off oil	0.90
Electric power for conveyer	0.04
Naphtha for cleaning off the oil	0.05
Total cost per hour	$3.79
Induction Heat	
Control circuit electricity	$0.04
Oscillator power	0.135
Labor, one man	1.00
Water for cooling circuit	0.108
Tube replacements	0.10
Total cost per hour	$1.38

Industrial applications of dielectric heating, though newer than induction-type heating, have expanded rapidly also. A recent application is in the field of core-baking in foundries. At the Lehigh Foundry, Lehigh, Pa., continuous dielectric baking of cores has been a principal operation for several months replacing conventional oven baking. A 25-kw electronic oscillator operating at 15 megacycles is used in the production of 500 pounds of uniformly baked cores per hour at an investment of $11,000 which includes the cost of the conveyer. A 20-second baking cycle is used for most cores as compared with a 2-hour baking cycle in conventional ovens. The ease of adapting the process to conveyer-type manufacturing reduces labor costs substantially.

High-frequency heating is not a cure-all for every commercial industrial heat problem. Because of the high investment represented in this type of equipment, the financial harzards are obviously great. If a purchaser of a high-frequency heating tool unexpectedly loses an important contract, for a long production run, of products readily adapted to the machine, the financial burden may be great and the decision to purchase may be unwise. The capacity cost for equipment per Btu per unit of time which these machines represent is greater than with other comparable heating tools. This entails higher fixed costs on the equipment investment, and the obsolescence factor is great because of rapid changes and developments compared to other heating tools. Despite these hazards the use of induction and dielectric heating is expanding rapidly because of the advantages inherent in the processes. In induction heating the major factor is the localized heating obtainable with extreme speed and control of the depth of heat penetration. In dielectric heating the uniform rapid heating accomplished throughout the mass when the product is of uniform loss factor represents a phenomenon not associated with other forms of heating. In certain instances equipment investments have been retired in a few months, but a 1- or 2-year retirement is the general trend when high-frequency heating is applied with sound engineering to industrial heating applications.

Table I. Proposed Band Number Designations for Frequency Bands Used in High-Frequency Heating

Band Number	Frequency, Cycles Per Second	
0	0–10	cycles per second
1	10–100	cycles per second
2	100–1,000	cycles per second
3	1,000–10,000	cycles per second
4	10,000–100,000	cycles per second
5	.1–1	megacycles
6	1–10	megacycles
7	10–100	megacycles
8	100–1,000	megacycles
9	1,000–10,000	megacycles
10	10,000–100,000	megacycles

Digest of paper 48-17, "Some Economic Aspects of Radio-Frequency Heating," recommended by the AIEE electric heating committee and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, Pittsburgh, Pa., January 26–30, 1948 and also at the AIEE North Eastern District meeting, New Haven, Conn., April 28–30, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

Lawrence M. Duryee, secretary of the AIEE electric heating committee, is with the Connecticut Light and Power Company, Waterbury, Conn.

Technical Education Trends in Mexico

JUAN M. RAMIREZ CARAZA

THE WORDS "TECHNICAL EDUCATION" have for me a wide democratic meaning, involving the development of technicians with a greater capacity to think, who are perfectly prepared to co-operate in everybody's well-being and to understand their own responsibilities to the public and to their country. Technical education has as its goal the unveiling of the student's own creative power. This is in opposition to what frequently is understood by the words "technical instruction or training" which suggest a restriction to personal development and a confinement to sets of instructions and practices which mechanize the individual and nullify his capacity to think.

The preparation of craftsmen was started in Mexico at the time of the Spanish colony, and it was given through religious schools and orphanages. The School of Mines was the pioneer in higher technical education, and in 1862 Benito Juárez founded the National School of Arts and Crafts, which gave the country many men important to the development of our industries. This school was changed in 1916 into Escuela Práctica de Ingenieros Mecánicos y Electricistas, which produced the first mechanical and electrical engineers prepared in México. Through later changes and adjustments, that school became what is now the Escuela Superior de Ingeniería Mecánica y Eléctrica where the students may select aeronautical engineering, communications and electronic engineering, electrical engineering, and mechanical engineering. The programs of study for these careers are very complete and modern, and are well suited to the needs of the present Mexican industry. They have been under constant revision in order to keep up with the advanced techniques that have appeared in the postwar period.

A few years after the foundation of this school, the electrical and mechanical careers were started also by Universidad Nacional de México, and the two schools together have been the main source of technicians for our industries.

The Escuela Superior de Ingeniería Mecánica y Eléctrica became later a part of the Instituto Politécnico Nacional, which is an institution with a wider scope in which technical education has been extended to other fields, such as biology, rural medicine, economics, and business administration.

Up to a few years ago, the two schools of mechanical and electrical engineering were capable of supplying the technicians for those specialties. The extraordinary present demand has made necessary new sources for technicians, such as the Instituto Tecnológico de Monterrey, created by the enterprising industrialists of that city.

Up to the present time graduate Mexican mechanical and electrical engineers have majored in mathematics, physics, and subjects related to industrial application. These graduates, on the whole, have turned out to be first class technicians. Study courses are being improved continually, but it is indispensable that serious thought now be given to training teachers, for the demand for technical specialists by industrialists has caused many highly trained professors to be absorbed by industry thus intensifying the problem of maintaining adequate teaching staffs. It is essential that higher education be favored not only to permit graduates to enter the teaching profession but also to supply the scarce, indispensable industrial investigators who can suggest new or better applications of national raw products. In this connection it is necessary to acknowledge the help that has been extended by the great North American institutions to Mexican technicians who are rendering such excellent services in Mexican industries.

The present trend of the systems of technical education points toward fitting our technicians to the needs of our ever increasing production. The aims may be summarized as follows:

1. Technical and cultural improvement of the workers of our industries. This is being done by the industries themselves under the co-ordinating action of the federal government. The Instituto Politécnico Nacional has started a vigorous program to the same end, and some other agencies such as the national railways of Mexico have been using for some time the most modern and effective methods for improving the quality of the workers.
2. Education to prepare those technicians of the subprofessional type of which our industry is in great need. The Instituto Politécnico Nacional has a courageous and important program to this end.
3. Higher education in engineering, biology, hygiene, and administration, in which attention is paid not only to the basic technical matters, but to the more subtle and not less important ones of public relations and responsibilities and human problems of industry. The education is complemented by extensive practices and the solution of actual problems.
4. Higher education to prepare better instructors who will stimulate and direct the students towards the Mexican industrial problems; and research technicians who will find new or better applications for our national resources.

I believe in Mexico's preparedness not only to survive, but to stand out among other nations already highly industrialized. In conclusion, the trend of technical education in Mexico has been, and I hope will continue to be, the basic element in a speedup of national production, which in the last analysis always returns to the training of the technician and his two primary qualities—capability and honesty.

Digest of paper 48-143, "Technical Education and Its Trend in Mexico," recommended by the AIEE education committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

Juan Manuel Ramirez Caraza is director, Escuela Superior de Ingeniería Mecánica y Eléctrica, Mexico, Federal District, Mexico.

Alexander Morton MacCutcheon

Lamme Medalist for 1947

Presentation of the Lamme Medal for 1947 to Alexander Morton MacCutcheon (F '26) retired vice-president of the Reliance Electric and Engineering Company, Cleveland, Ohio, and a past president (1936–37) of the AIEE, was made June 23, 1948, during the AIEE summer general meeting at Mexico, Federal District, Mexico. Mr. MacCutcheon was honored for "his distinguished accomplishments in the development of motors for industrial needs, notably in the steel industry." The medal has been awarded each year since 1928 to an engineer "who has shown meritorious achievement in the development of electrical apparatus or machinery."

BENJAMIN GARVER LAMME
1864 · 1924
THE ENGINEER VIEWS HOPEFULLY THE HITHERTO UNATTAINABLE

The Lamme Medal

The Lamme Medal

TITUS G. LeCLAIR
FELLOW AIEE

FOR the past 19 years the Lamme Medal has been awarded annually to a member of the Institute for "meritorious achievement in the development of electrical apparatus or machinery." On this 20th anniversary, the name of A. M. MacCutcheon is to be added to the 19 other illustrious names of men who have received this medal.

THE MEDAL

The Lamme Medal is made possible by bequest from the late Benjamin Garver Lamme who was chief engineer of the Westinghouse Electric Corporation, and the Institute was given the responsibility for selecting the recipient and presenting the award at a suitable convention.

It is quite fitting that this award for achievement in the development of apparatus and machinery should have been sponsored by Mr. Lamme. The same intense interest which inspired him to many important developments in this field made him realize the importance to the industry of suitable recognition to those men whose developments are the backbone of that industry. This spirit is expressed in the words engraved on the obverse of the medal accompanying the likeness of the donor. This inscription, taken from one of Lamme's writings, reads: "The engineer views hopefully the hitherto unattainable." The reverse of the medal represents Niagara, the birthplace of large-scale hydroelectric power where the great electric generators designed by Mr. Lamme initially were installed. In the background is a modern industrial city, symbolic of the progress made possible by electric power.

Benjamin Garver Lamme was born near Springfield, Ohio, January 12, 1864. He grew up on a farm, received his early education in the country school, and went from there to the Ohio State University, from which he was graduated in 1888 with a degree of mechanical engineer. Early the following year he entered the service of the Westinghouse Electric Corporation at Pittsburgh and a few months later began his career as a designer of electric machinery. His success in this field was phenomenal, covering as it did pioneer work in d-c generators, synchronous converters, induction motors, and single-phase railway motors, on all of which his engineering skill left a permanent mark. Mr. Lamme was recognized as the outstanding electrical designer of the Westinghouse corporation almost from the time he began his work, and was chief engineer of the company for many years prior to his death in 1924.

DEFINITION OF CRITERIA

The Lamme Medal committee, during the past four or five years, has been attempting to define more definitely the field of engineering from which the recipient of the award should be selected. Mr. Lamme's original bequest states that the award should be made for meritorious achievement in the development of electric apparatus and machinery. The discussion in the committee has hinged on the meaning of the term "apparatus and machinery." Should this phrase be interpreted to mean apparatus and machinery as Mr. Lamme knew it, or should it include the broader field of the newer equipment developed in the past 20 years?

The committee surveyed the material written about Mr. Lamme and the material written by Mr. Lamme himself. All this material indicated that Mr. Lamme had no intention of placing a narrow limitation on the qualifications for receiving the award. The committee believes that the word "development" itself denotes progress and that, therefore, progress in the broader field should be included in considering future developments. Mr. Lamme was himself a prolific inventor and intensely interested in any new

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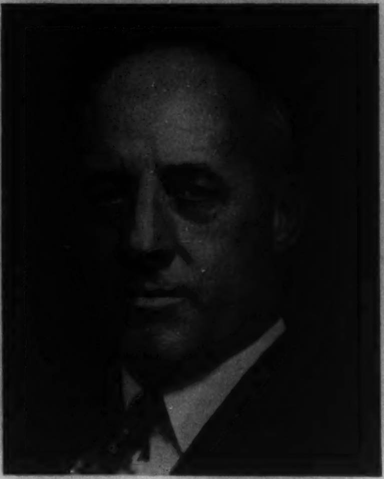
Full texts of the addresses delivered during the Lamme Medal presentation ceremony at the 1948 AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948.

Titus G. LeClair is supervising development engineer, Commonwealth Edison Company, Chicago, Ill.

device or apparatus which involved engineering design. The committee, therefore, has adopted the interpretation of the term "meritorious achievement in the development of apparatus or machinery" to include any work which shows development of the theory involved, development of the characteristics of the materials employed, development of over-all design, and development in other ways which results in substantial improvement in electric apparatus and machinery.

In honoring Mr. MacCutcheon, the Lamme Medal committee was unanimous in the opinion that the Institute is honoring a man who has an outstanding reputation as a designer of new types of machinery and control equipment which have been of great and lasting benefit to industry. His qualifications admirably fulfill the definitions adopted by the committee.



Alexander M. MacCutcheon

The Medalist's Career

F. E. HARRELL
FELLOW AIEE

As CAREERS unalterably are preceded by the occurrence of "vital statistics" I would advise that the 1947 Lamme Medalist was born Alexander Morton MacCutcheon on December 31, 1881, in the family of a Methodist minister then residing in Stockport, N. Y.

Mr. MacCutcheon spent his early years in various communities along the Hudson River and went on to the Albany State Normal College from which he was graduated in 1901. Next followed four years of teaching high school mathematics and science with some athletics coaching thrown in for good measure.

With some earnings from the teaching experience, and a four year scholarship, Mr. MacCutcheon entered Columbia University along with his brother. They both also had jobs with the Hudson River Day line. Graduation in electrical engineering in 1908 from Columbia prepared him for the next two important steps in his career, first his marriage, then his employment by the Crocker-Wheeler Company at Ampere, N. J.

CAREER IN INDUSTRY

After five years at the Crocker-Wheeler Company, during which time he was successively in engineering estimating, in drafting, and in electrical design work, he joined the Reliance Electric and Engineering Company in Cleveland, Ohio, where he was to take charge of all new design work in 1914.

Mr. MacCutcheon went on to become chief engineer for the Reliance company in 1916, director in 1920, and engineering vice-president from 1924 until 1946 when he retired from active participation in the company. He has been responsible for most of the basic engineering practices of that company.

During World War I, on leave from the Reliance Company to be an engineering officer in the Navy, he had the unusual experience of transferring (with due diligence and extra effort) from the engineering side to the line officers side. He was released in 1919 as lieutenant in charge of fire control on the *USS Louisiana* and he was aboard at the time the *Louisiana* was fired upon mistakenly as a target.

In 1914, when Mr. MacCutcheon was commissioned to design a line of d-c motors with interpoles, he found that the most adequate treatise dealing with the theoretical calculation of the desirable shape and strength of interpoles had been written by a German engineer named Arnold, so he proceeded to translate it for the edification and guidance of his associates. He made trips to Europe later in the specific interest of engineering co-operation.

The act of designing this line of interpole d-c motors led Mr. MacCutcheon to urge that the experience of a very appreciable number of electrical maintenance engineers in customers' plants should be consulted and invited to criticize the design on paper before it was built. Weighing and profiting from the invited criticism of 35 or more maintenance engineers resulted in increased emphasis on certain features both mechanical and electrical which would not have been emphasized, but which resulted in increased life, easier maintenance, and greater interchangeability of parts.

Later on, when specific motor application problems were up for solution, he was insistent on having a Reliance engineer see at first hand the nature of the problem in the customer's plant so it could be sympathetically, intelligently, and co-operatively attacked. No one is as enthusiastic over the solution of a problem as the person who has assisted in solving it.

SERVICE OUTSIDE INDUSTRY

Mr. MacCutcheon demonstrated through all of his years at Reliance a keen interest both in young men and in teaching. The result of this interest occasioned his being

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F. E. Harrell is manufacturing vice-president, Reliance Electric and Engineering Company, Cleveland, Ohio.

elected to honorary membership in Tau Beta Pi by the Michigan chapter, and in Eta Kappa Nu by the Case Institute chapter.

In the AIEE Mr. MacCutcheon became a Fellow in 1926, having joined in 1912. He has served as chairman of the general power application committee and the Standards committee, and as a member of committees on application to iron and steel production, electric welding, electric machinery, and technical program. He served as a director (1928–32) and as president (1936–37). He has served on the American Standards Association Council, the Electrical Standards Committee, the United States National Committee of the International Electrotechnical Commission, and the American Engineering Council.

Mr. MacCutcheon has been prominent in activities of the Association of Iron and Steel Engineers of which he has been a member since 1917, he has delivered papers before many other technical organizations, he took a very prominent part in the successful completion of the project wherein electric motor mounting dimensions were standardized by the general engineering committee of the National Electrical Manufacturers Association, he is the author of a number of patents, and recently was active in the formation of the Cleveland Technical Societies Council. As chairman of the water action committee of that body the committee was commissioned by the city government, to advise with it on its future development of the water supply for metropolitan Cleveland.

With such a background, I am sure you can well under stand why personally, I with many others, take Mr. MacCutcheon's statement that he has been overrated all of his life as a sign of the true modesty of the man who truly "views hopefully the hitherto unattainable."

Co-operative Engineering

A Method Used in Developing Motors for Industrial Need

ALEXANDER M. MacCUTCHEON
FELLOW AIEE

IN A COUNTRY where success is achieved under a system of free enterprise, a deep significance attaches to an engineering award bestowed, not by a dictator nor an hereditary monarch, but by a great democratic engineering organization followed the recommendation of a committee of the recipient's fellow engineers. This significance is deepened when the award has been established in memory of one of the greatest of engineers. An engineer so fortunate as to receive such an award hopes that the record of the factors which contributed to his success will be a source of inspiration to younger engineers. Since inspiring leadership is so important a factor, I was most fortunate for my first chief was Gano Dunn, an Edison Medalist and a past president of the Institute. My second chief was Clarence Collens, a founder and early president of the National Electrical Manufacturers Association. These men inspired all who served under them.

PRINCIPLES OF CO-OPERATION

The counsel, precept, and example of these two engineers developed in me a conception of an engineering co-operation that should include, not only the engineers in one's own organization, but also the engineers who select and use the product, those who supply materials for its manufacture, those of competitors in advancing the profession, and all engineers through such organizations as the AIEE.

These men taught me that effective co-operation rests on fundamental principles: all participating in the co-operation must profit thereby and their integrity be beyond question; hard work is the first requisite for success and no amount of native ability can compensate for its lack; the most valuable assets that a company can possess are the merit of its product and the confidence of its customers; the requirements for a piece of equipment should be studied in the plant where it is to operate and with the engineers who are to direct its use; responsibility for a product does not terminate at the expiration of a guarantee; success can be achieved most surely through a fine organization co-operatively striving for a common objective; the relation between a customer and a supplier should be that of partnership; successful design places quality first but always considers cost.

My associates and I resolved to adopt these principles of co-operative engineering. We recognized the great opportunity in supplying a motor best suited for its work. We planned to devote experimentation and research to the co-operative art of motor application and fully utilize the knowledge and experience of the customers' plant engineer. As a part of the large group devoted to extending the use of electricity in the industry field, we hoped to contribute our share. Any success which we have achieved has resulted from inspiring leadership, an unusual degree of co-operation from other engineers (notably in the steel mills), and the opportunity that has been presented to us.

An electrical engineering graduate of 1908 joined the profession at a most opportune time. The great electrical pioneers, through research and invention, had revealed a startling new form of energy that was peculiarly adaptable to transmission through conductors; susceptible to transformation from low to high intensity or conversely; that could be transmitted and utilized either as direct or alternating current and readily converted from one to the other.

Forty years ago a young electrical engineer was privileged to attend some of the most dramatic, controversial, and interesting meetings that the AIEE ever has sponsored. There was debated the relative merit of alternating and direct current; there were compared large generators, efficient and economical but requiring long distance transmission, with small units located close to where the power would be utilized; there were held many discussions of whether a large group of machines should be driven by a single large motor through mechanical transmissions or these be eliminated by individual drive. The fundamental advantage of a-c generation and distribution was established early but even today many processes are served better

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Alexander M. MacCutcheon is retired vice-president, Reliance Electric and Engineering Company, Cleveland, Ohio.

through direct current and many plants require isolated generators.

While the pioneers had demonstrated that the new form of energy could be utilized effectively through electric devices, there was a great need for improved equipment. Generators and power lines were limited in capacity; the early motors were heavy, expensive and not sufficiently free from maintenance difficulty; d-c motors successfully operated in but one direction and did not provide wide speed adjustment, now a most valuable characteristic.

There followed a period of experimentation, research, and demonstration as to how this new form of energy better might be generated, transmitted, and utilized. Each existing mechanism or device was accepted only so long as there was available nothing safer, more efficient, or more economical. The very versatility of this new form of energy added complexity to its problems and "basic economics" controlled every decision. Factors considered were safety, production, convenience, standards, investment, and cost. Accurate analysis and evaluation of all the evidence and a correct integration leading to a logical conclusion exceeded in complexity the problems of basic design.

So many of the problems were solved so successfully that the use of electricity rapidly increased. Engineering skill in developing new uses appeared to be unlimited. Electric power lines were safer and more economical than steam lines. Lower cost of electric equipment, lower rates for power, standardized designs meeting the users' need, all stimulated the adopting of electric energy. Decreased cost increased acceptance and increased acceptance decreased cost.

Few problems have involved more study, research, and discussion than the problem of providing for a controlled adjustable speed, so essential to maximum production in many industries. Engineering economics convincingly demonstrated the advantage of a-c generation and distribution and the simple inexpensive constant speed a-c motor, so adaptable to mass production, adequately serves many drives. There have been presented many ingenious mechanical and hydraulic devices for converting the constant speed of the a-c motor to the adjustable speed desired and a simple economical adjustable speed a-c motor would be a desirable solution. However the d-c motor has been so greatly improved through many changes in design, particularly the use of interpoles, that it provides rapid reversal, operation in either direction, and wide speed range through field control. It therefore remains the standard with which all other means are compared.

The steel industry, a pioneer in the adoption of electric power, early concluded that d-c motors should be continued on cranes and where adjustable speed was essential. The necessary direct current would be provided through rotaries or motor generator sets and distributed through a second plant network.

Meanwhile a fuller recognition of the readiness with which electric energy can be converted and the desirability of eliminating a second plant distribution system have led to the recommendation of "spot conversion" of the plant a-c power to any form desired. This can be accomplished through a converting or control unit, economically designed for operation under plant conditions, which is located close to the spot where the power is to be utilized. Adoption of this recommendation makes available high- or low-frequency alternating current of high or low voltage or direct current at the voltage most suitable. If through such a unit direct current is supplied to a motor, or to a group of motors of the same speed characteristic, voltage and field control can be combined to secure wide speed ranges far beyond those possible through field control alone. The difficult problems in speed control of reversing planers, sectional paper mill drives, and high speed calenders have been solved best through such a scheme and the results have justified the investment.

While in 1908 there was recognition of the wide field for electric power, there was little realization of the extent to which it would be utilized.

There was then no conception of tremendous hydro and steam generating plants, some of over 100,000 kw. Today the generating capacity, in North America alone, is more than 50,000,000 kw. This represents the courage and foresight of all in the utility field. It is of supreme interest that during the time of critical war shortages there was never a critical shortage of electric power.

Then unforeseen were millions of electric motors operating refrigerators and vacuum cleaners or serving farmers in developed areas.

CO-OPERATION IN ENGINEERING

Since 1908 have occurred many unexpected developments such as sizable fully enclosed a-c motors reversing 40 times a minute at acceptable temperatures; fully explosionproof motors contributing much to the great safety program; large reversing roller tables for conveying material with each roller individually driven; water or air-cooled motors with shaft extension operating in furnace temperatures of more than 1,800 degrees Fahrenheit; giant presses where clutches have been eliminated through direct-connected a-c motors which start and stop for each stroke of the press; motors forced ventilated by filtered air for operation in extremely dirty locations; program control for automatic operation of complicated processes requiring many different speeds.

Electric welding expanded until it is an industry in itself. Steel and other metals are treated and tempered through high-frequency induction. Giant bombers and transport airplanes utilize more than 100 motors apiece as well as numberless other electric devices. Standardization has made available to all industries motors of standardized mounting dimensions. Production has been increased through adjustable speed individual drive on machines in all industries and the ultimate is not yet achieved.

These seeming miracles have been accomplished primarily through co-operative engineering inspired by the Lamme theorem, "The engineer views hopefully the hitherto unattainable." They do not represent the accomplishment of the electrical engineer working alone. It has been his function to recognize need and opportunity in the electrical field; to initiate research and experimentation in the problems presented; to inform himself of technical progress in other fields that may assist him; to lead and co-ordinate the co-operative endeavor to find a solution and never to be willing to admit that a solution is impossible.

In the past accomplishment all branches of engineering have participated so successfully that a 40-horsepower 1,800-rpm motor of today is no larger and no heavier than was the same speed 10-horsepower motor in the year 1900. This has resulted from the use of better materials, improved ventilation, standardization, mass production, and great ingenuity.

The mechanical, metallurgical, and chemical engineers have developed lighter, better, and more economical materials and have opened wide fields for the use of electric energy in electrolytic processes and heat treating. The welding engineer has developed new methods and suggested designs permitting the use of welded parts. The ventilation engineer has developed new theories of heat transfer and suggested better methods of cooling as in the enclosed fan-cooled motor. The production engineer has advised with the designer, has devised new methods of manufacture, improved facilities for handling, and led in the installing of mass production machinery. The application engineer has rendered an inestimable service by firmly insisting on economical equipment best fitted to accomplish the desired result and has contributed ingenious suggestions for design improvement. The NEMA continuously has insisted on the observance of standards and that no special be developed without convincing evidence that the result could not otherwise be obtained. Many times an essential special has become the future standard through a minor change in design.

THE FUTURE

Should the young electrical engineer of the present feel that the astounding technical progress of the last four decades indicates that all major problems have been solved and that now the door of opportunity is closed to future great achievement? Never has the need and opportunity for technical advance been so great. Solutions of the past have but opened broader problems which challenge the young engineer to still greater achievement in the future.

Additional contribution to the field of safety sorely is needed. Still smaller, lighter, and more economical motors may be the result of still further improved design using silicone or other heat-resisting resin and still lower loss copper and steel. The automotive industry still leads in methods of mass production. The motor designers of the past and the present bequeath to those of the future the problem of a controlled adjustable speed. Shall it be through spot conversion of the distributed alternating current and shall this spot conversion be through a rotating control unit or through electronic tubes? Will a superior method of conversion be invented or will some designer triumph through an ideal adjustable speed a-c motor?

What of hydrogen-cooled generators, gas turbines, improved Diesels, new sources of light, and remote control of bombs and bombers? What of radar and television and the startling developments in the field of nuclear energy? Is there a possibility that electric power will be produced from some yet unknown source of primary energy and be transmitted and distributed through a conducting medium more efficient, economical, and safer than any now available? If the next 20 years produce such seeming miracles, who would deny that the results had been forecast by the astounding rate of acceleration of technical progress through the decades of the past?

If the engineer and the scientist are to achieve the maximum success in solving the numberless problems still ahead, they must be permitted to work in an era of peace and co-operation, devoting their energies to the improvement of man's estate rather than to developing more startling methods of mass destruction. How this may be accomplished presents a more perplexing problem to the family of nations than ever has faced the engineering profession. Who would say that a solution is impossible? In this deeply troubled world is it not possible to develop great leaders, unselfishly devoting themselves to true world progress, who will follow the co-operative engineering method of collecting all available facts and information, analyzing and evaluating wisely and correctly, and who then will deduce a logical and just solution in the common interest of all? God grant that this may be.

Concentrated Electric Power

Electrically the largest transformer ever built by the Westinghouse Electric Corporation, this 110,000-kva 3-phase 142-ton transformer was shipped recently to the Buffalo Niagara Electric Corporation for installation at that company's number 2 plant of the C. R. Huntley steam-electric generating stations near the city of Buffalo, N. Y.

Attenuator Materials for Microwaves

G. K. TEAL   M. D. RIGTERINK   C. J. FROSCH

Microwave development has brought with it many related devices, one class of which is circuit elements having the property of attenuating or absorbing microwaves. Investigation of the microwave properties of a variety of solids led to the application of electrically inhomogeneous ceramic and plastic materials such as silicon carbide dispersed in porcelain, and graphite dispersed in phenol formaldehyde.

THE INCIDENCE of World War II gave rise to demands for radar and communication systems requiring the development of a large variety of microwave devices. A considerable number of these employed "lossy" solids that have been called attenuator materials since they may differ considerably from those solids normally classed as resistor materials.

The type of material to be recommended must vary with the particular requirements of the job. Ceramic materials are particularly adapted to high-power and wave-guide applications. Plastic materials are particularly valuable for coaxial usage and certain compositions have served admirably for high power absorption. The plastic materials may be somewhat more suited to quantity production and thin tapers than the ceramic type. However, the best high-power attenuators made so far have been with ceramic materials. Film materials are particularly useful for variable attenuators and also have been widely used in pads and terminations. They are cheap and it is relatively easy to fabricate devices from them. Rubber-bonded materials are particularly adapted to those applications requiring the attenuating material to fill a cavity of odd design.

NEED FOR NEW MATERIALS

At the time the needs arose there were virtually no attenuator materials available for many new applications. The shortcomings of the few known materials fell into one or more of the following categories:

1. They were unable to handle the available power.
2. The methods of preparing them did not permit standardization to give dependable electrical characteristics.
3. They were not stable.
4. They were not suited to giving the desired physical configuration.
5. They did not permit the attainment of some special characteristic that was required for a specific job, for instance, constant attentuation with absorption of high power.

In Figure 1 are shown in simplified form two microwave systems to illustrate typical uses of attenuator materials. In the case of the measuring equipment shown in (*a*) a signal generator is sending radio frequency signals *A* of a few centimeters wave length into a metal wave guide. Normally the signal generator is protected from reaction from the remainder of the system by a pad *B* of 10 to 30-decibel attenuation inserted at this point to stabilize the oscillator against variations in frequency caused by changes in the load impedance. In order to adjust the output level of the signal by measurable amounts or to reduce it to a conveniently measurable level a variable attenuator *C* is provided in the circuit at the point shown. It is followed by the material or device whose characteristics are to be determined. Another variable attenuator *D* may be inserted between the material under study and the receiver *E* to permit adjustment of the output level. The receiver is a sensitive element, such as a thermistor or detector, which is actuated by the output signal.

APPLICATION TO RADAR SYSTEMS

The case of a radar system is illustrated in (*b*) of Figure 1. Since the output of this system should be as nearly the maximum output of the magnetron generator as possible, the attenuation in the wave guide is reduced to a minimum and the antenna which radiates the beam into space is designed to give a minimum reflection of the signal back towards the signal generator. Sometimes, however, conditions may arise leading to the reflection of an appreciable part of the signal. The magnitude of the reflected power can be determined and the output monitored by means of a directional coupler. Such a directional coupler employs terminations in a manner permitting the magnitudes of the signal and reflected waves to be separately determined by measurements at the probes *P* and P_B, respectively. Thus, for instance, known portions of the signal and reflected waves enter the lower chamber through apertures, the signal portion proceeding to probe *P* while the reflected portion is absorbed by the termination shown. In the upper chamber the situation is reversed, the signal portion being absorbed, while the reflected portion is determined at P_B. It is general practice during tune up of a radar system to replace the antenna by a dummy antenna consisting of a termination that will effectively absorb all the energy normally radiated. This is necessary to reduce interference between systems and to prevent the detection by the enemy of radiated power during tune up. To permit tune up the dummy antenna must absorb the full output of the transmitter peak power from 50 kw to more than a megawatt and average powers of 50–1,200

Essential substance of technical paper 48-68 "Attenuator Materials, Attenuators, and Terminations for Microwaves," presented at the AIEE winter general meeting, Pittsburgh, Pa., January 26–30, 1948, and scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

G. K. Teal, M. D. Rigterink, and C. J. Frosch are all with Bell Telephone Laboratories Inc., Murray Hill, N. J.

The authors wish to acknowledge the aid of their associates in other groups. They particularly are indebted to W. A. Tyrrell of the Holmdel Laboratory for his invaluable aid and advice.

watts. The great difference between peak and average powers is due to the pulsing of the radio frequency with short duty cycles.

The more important applications of the attenuator materials to be described proved to be terminations for dummy antennas and for directional couplers, primarily for moderately high and very high powers.

GENERAL REQUIREMENTS OF ATTENUATOR MATERIALS

It is necessary that the attenuation be high and that the termination shall reflect negligible amounts of the signal. The material should be chemically stable, should not be warped by heat, and should conduct the heat readily from inside the guide to the exterior. For quantity production the characteristics must be readily reproducible and, to minimize the number of necessary materials, it is desirable that the one chosen shall be sufficiently adaptable to permit its fabrication in a variety of designs. Since space is often at a premium the material should permit compact designs.

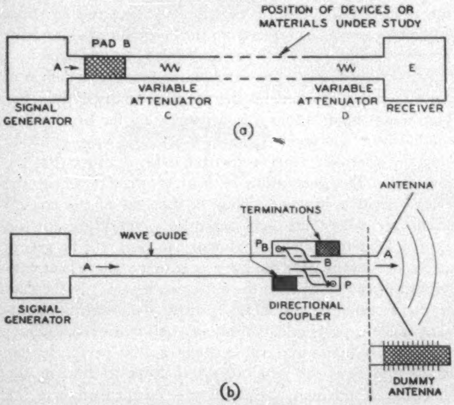

Figure 1. Schematic of typical applications of attenuator materials in (*a*) measuring equipment and (*b*) radar

CLASSIFICATION OF MATERIALS STUDIED

From the point of view of the structure there are two general classifications of attenuator materials: Lossy dielectrics and resistor strips.

Homogeneous dielectrics have been used as attenuator materials, but have serious drawbacks. Those like polystyrene, methyl methacrylate, and bakelite do not attenuate waves strongly and there are no suitable means of controlling the loss. The materials with higher loss, such as water, exhibit their loss through molecular resonance, resulting in attenuating properties sensitive to temperature and frequency. The solids described herein avoid some of these drawbacks and, it is believed, more nearly meet the requirements of commercially useful materials. They are dispersions of conducting or semiconducting particles in low loss solid dielectrics. Materials employing ceramic, plastic, and rubber bonds have been investigated. The d-c conductivity and other attenuating properties of these materials depend on a number of factors such as: The volume content of semiconductor, the specific resistances of the bond and semiconductor, the particle shape, particle size, dispersion of the particles in the bond, and the methods of making the composite solid.

For the second type of attenuator material cited, a resistor strip, similar combinations of such solids can be employed as films on ceramic, mica, or plastic supports. The bond is normally a plastic.

Although the physical structures of these materials appear very similar the properties obtainable are widely different, the methods of employing them vary considerably and the chemical methods of fabricating them cut across the four rather well established technological fields of ceramics, plastics, rubbers, and finishes.

GENERAL INFLUENCE OF THE DIELECTRIC PROPERTIES ON APPLICATION

In Figure 2*a* is shown a metal wave guide filled to the right with a lossy dielectric and to the left with air. A wave traveling to the right is partially reflected on encountering the dielectric while the remainder enters the solid and is attenuated by it. The portion of the wave reflected may be determined from measurements of the maximum and minimum voltages of the standing wave resulting from superposition of the signal and reflected radio frequency. The losses due to dielectric absorption and reflections are important considerations and were subjected to much study. Moreover, reflections that are too small to be serious from the point of view of loss are often of great importance because of the influence they may exert on the mode of operation of a microwave oscillator.

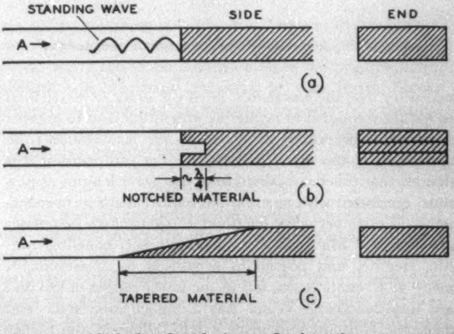

Figure 2. Methods of reducing reflections from attenuator structures in wave guide

For the disposition of dielectric shown it is possible to determine the impedance of the dielectric filled portion and from this the dielectric constant and tangent of the loss angle. With these data it should be possible, by application of electromagnetic theory, to calculate the reflections and attenuation due to a piece of attenuator material of arbitrary but known geometry in a wave guide. However, due to the difficulties of making measurements of the dielectric constants of high loss materials, because the theory of tapered structures is complex and not well developed, and because the calculations are laborious, it was necessary to carry out the present development largely empirically.

It may be helpful, however, to consider the relationships between the fundamental constants of a solid and its suitability as an attenuator material. In a termination it is necessary that the loss should be of the order of 40 decibels to reduce the signal to negligible magnitude and to prevent appreciable reflections from behind the termination from appearing at the signal generator. For compactness it is desired that this be obtained in as few wave lengths as possible, consistent with meeting the requirements as to reflections. Losses per wave length of 15–20 decibels or greater are desired. Materials such as polystyrene, bakelite, transite, steatite, and porcelain, according to measurements made at 10 centimeters, fall in the lower ranges of loss and are unsatisfactory. Water has a higher loss factor and dielectric constant and gives a loss falling in the higher range but seems unsatisfactory for a variety of reasons. The loss requirements of the materials of interest for terminations must have values of 0.1 to 1.0 or even more for the tangent of the loss angle or else have dielectric constant values greater than 40.

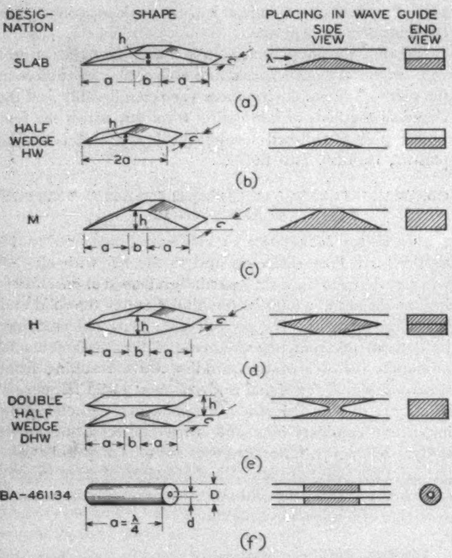

Figure 3. A variety of fixed attenuator pad designs

The reflection from a lossy dielectric increases with increasing dielectric constant and tan δ and is more sensitive to changes of dielectric constant than to changes of tan δ. It is therefore necessary to alter the geometry of the air–solid interface further in order to reduce the reflections to permissible values.

DIELECTRIC AND THERMAL PROPERTIES

Measurements of several dielectric properties of ceramic and plastic materials were made. One type of material employed has been a ceramic consisting of silicon carbide particles dispersed in porcelain. The dielectric constant for porcelain is about 6 and practically constant with frequency; for increasing amounts of silicon carbide the dielectric constant increases to as much as 35 to 40. Another type of material used quite extensively is a lossy plastic material consisting of graphite particles dispersed in bakelite resin. The dielectric constant as measured at about 3,000 megacycles increases from the low value of about 3 for bakelite to about 70 at 45 per cent graphite by weight.

Another property of the attenuator material which is of considerable importance is the thermal conductivity. For high power applications it is important for the heat to flow readily from the inside to the walls of the wave guide to keep the internal temperatures from being destructive to the material. The generation of heat is greatest where the electric field is highest. Thus in the case of the coaxial conductor where the field builds up logarithmically on approaching the center conductor the heat will be generated most readily near the inner conductor where heat cannot escape so readily as at the outer conductor. In the case of the rectangular guide the electric vector of the dominant wave is perpendicular to the long side of the guide; and has its maximum value along a line perpendicular to the middle of the long edge and drops to zero at the short edges; the heat, therefore, must escape from near the center of the guide to the four faces. In addition to these considerations concerned with the solid in an operating device, in the case of plastic materials it is important in producing strain free moldings that the heat shall flow readily into the material so that curing of the resin is uniform throughout a structure.

GENERAL DESIGN FEATURES

Now, as mentioned before, it is necessary in working with these materials to alter the blunt air–solid interface shown in Figure 2*a* in some manner to reduce the reflections to acceptable values. There are at least two well-known general methods to reduce the reflection of microwaves at air–dielectric interfaces. One of these is to design the end of the dielectric with an approximately quarter wave notch, as shown in Figure 2*b*, such that the reflections from the outside and the inside of the notch are 180 degrees out of phase and therefore interfere destructively. This is satisfactory for narrow frequency applications and is feasible from the point of view of fabrication. For wider band applications, however, it is more satisfactory to employ some type of taper such as is shown in Figure 2*c*. While from the electrical point of view it is best to introduce the taper into the radiation field at its weakest point, that is, at the edge of a rectangular guide or at the outside of a coaxial conductor, other considerations such as mechanical properties of the materials and manufacturing methods may enter in and suggest the advisability of adopting some other way. This is true in the case illustrated in Figure 2*c;* the taper is from one wide face to the opposite one. For such a taper the standing wave ratio oscillates through maxima and minima of gradually decreasing magnitudes. Approximately one to seven wave lengths is the usual choice because of the necessity of reducing the space to a minimum. The restriction on taper length is usually greater in the case of attenuators or terminations for the longer wave lengths due to the larger dimensions of the device.

APPLICATION OF LOSSY SOLIDS TO ATTENUATOR PADS

A variety of specific fixed attenuator pad designs was studied as indicated in Figure 3. Most of these were for rectangular wave guides. Various combinations of ceramic and plastic materials and wave guide and coaxial pads were studied. Two of the designs receiving considerable study were the half-wedge type of Figure 3*b* and the *M* type of Figure 3*c*. The first seemed particularly well adapted to the lower attenuation range of 0–20 decibels while the latter was perhaps better for higher values of attenuation. Some of the fixed attenuator pads are shown in Figure 4.

It was found that the characteristic of a ceramic pad not only could be influenced greatly by the bond, the main conductor constituent, and the pad design, but also by the temporary binder used for the green ceramic attenuator material.

For high power pads it is especially important that the temperature coefficient of attenuation shall be very low, and a pad of very low attenuation to absorb most of the power is often desirable.

APPLICATION OF FILM MATERIALS

The second general classification of attenuator materials mentioned was resistor strips. Considerable work was done with sprayed resistor films of graphite pigmented acryloid and graphite pigmented silicone. The first material has been of considerable value as a readily applied lossy material to stop leakage between a metallized radio frequency lens and its enclosing metal horn. The second has been of value in applications where moderate powers of the order of several watts are to be dissipated since the organo-silicon medium will withstand charring at very much higher temperatures than can be tolerated by more conventional organic media. These graphitized silicone films may be employed on ceramic or mica support.

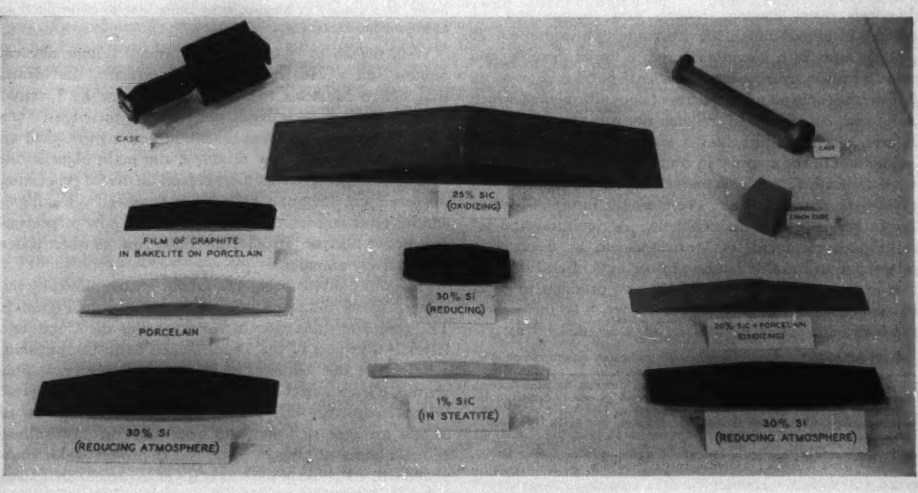

Figure 4. Examples of ceramic attenuators

FUTURE TRENDS

The materials and designs discussed here were developed and produced under the urgent conditions incident to the war. They served the purposes for which they were developed very satisfactorily. Several of the designs were produced in relatively large quantities by outside suppliers working to the Bell Laboratories specifications. At the end of the war the large increase in the demands for units and additional designs had led to the formulation of plans for large scale production of additional designs.

In the future it seems likely that interest in this field will center more on materials and designs for precision jobs with less emphasis on the power handling capacity, which was of prime importance in the present development.

Utilization of Mexico's Hydraulic Resources

ADOLFO ORIVE ALBA

IN 93 PER CENT of Mexican territory, irrigation is required to insure agricultural production. In the remaining seven per cent of the nation's territory, rainfall is abundant and sufficiently well distributed to assure enough water to cultivate the land, but here costly sanitary and drainage works are necessary.

Through utilization of the total water available from Mexican rivers flowing through arid regions and the rainfall of humid zones, Mexico could cultivate about 25 million acres with harvests assured as far as these depend upon a sufficiency of water. Besides these 25 million acres, Mexico has only 35 million acres of agricultural land which only can be cultivated relying on rain water. These figures, when consideration is given to the size and the population of the country in comparison with other countries, indicate that Mexico never can hope to become a great agricultural nation. Therefore the future of Mexico lies in her industrial development. Agricultural and industrial developments of Mexico should be directed to securing a measurable increase in her agricultural production and the transformation of her raw products to effect the establishment of a vigorous industry. To these ends, the hydraulic policy of Mexico may be defined as:

(*a*). All of the water of Mexican rivers which flow through arid, semiarid, and semihumid zones must be utilized to irrigate the largest possible areas of land. Mexico must consider as a grievous loss any water that is permitted to flow into the sea from her rivers which has not been utilized previously to irrigate lands susceptible of cultivation and that lie adjacent to their courses.

(*b*). Before river water is utilized to irrigate, whenever possible it should be stored and used to generate the maximum possible amount of electric energy, for the best way to further the industrial future, so necessary to Mexico, is by being able to count upon an abundant and cheap supply of power.

With regard to rivers flowing through humid tropical regions and where irrigation is unnecessary, the factors that define Mexico's hydraulic policy must be reversed there, inasmuch as water is not required to irrigate. As the perspective is excellent that those regions will yield an abundant supply of raw products, the main objective of hydraulic projects started there should be that of generating the maximum amount of electric power as well as seeking to control river courses and regulating their flow to prevent destructive floods that devastate those regions when water is excessively abundant.

How this policy is being carried out is exemplified by the three projects indicated on the map shown in Figure 1. The complete utilization of the waters of the Cupatitzio River is a project of the Tepalcatepec Basin Commission, a branch of the Ministry of Hydraulic Resources. This venture is shown on the map as the "Tepalcatepec Project." When completed, this project will provide irrigation of 62,500 acres of rich soil and generation of 231 million kilowatt-hours of power. The Nazas project when completed will make use of the Nazas River to provide irrigation for some 405,000 acres of land and will permit generation of about 141 million kilowatt-hours of power. Finally, the Papaloapan project will harness the great tropical Papaloapan River for the generation of power, to prevent annual floods that devastate productive lands and villages, and to facilitate navigation along the river.

This policy of utilizing the hydraulic resources to irrigate and generate power is the only adequate, possible policy for a country with the physical and water problems and soil characteristics to be found in Mexico.

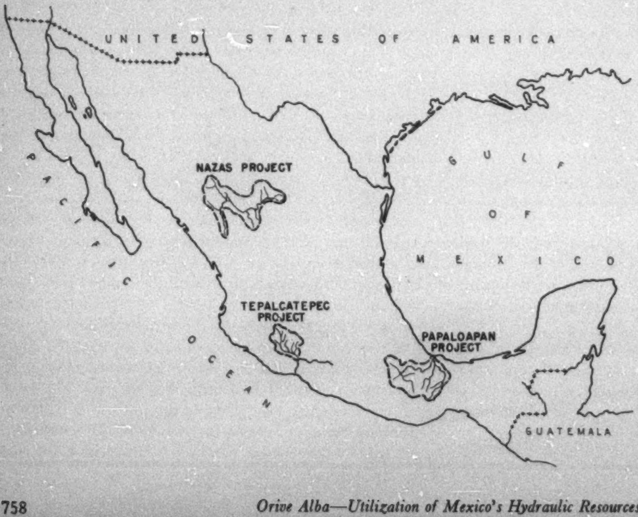

Figure 1. Map showing the location of the Tepalcatepec, Nazas, and Papaloapan River projects; several other important works of this kind are being executed in Mexico

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Digest of paper 48-151, "Full Utilization of Mexico's Hydraulic Resources Through Multiple Purposes," recommended by the AIEE power generation committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21-25, 1948. Scheduled for publication in *AIEE TRANSACTIONS*, volume 67, 1948.

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Editor's Note: A previously published article on a related subject is "Mexico's Electrification Program," by Basil Nikiforoff, Alejandro Perez Urquidi, Alfonso Fernandez Del Busto, and Oscar R. Enriquez, which appeared in *ELECTRICAL ENGINEERING* (*part I—EE, May '46, pages 193-7; part II—EE, June '46, pages 245-51*).

High-Energy Particle Accelerators

J. R. WOODYARD

The development of high-energy accelerators has been the forerunner of steady advancement in nuclear research. This study of four basically different kinds of machines for producing high-energy charged particles will give the reader a basis for more thorough understanding of other current literature about atomic experimentation. This is the ninth of a series of articles developed by the AIEE nucleonics committee; the entire series will be published in pamphlet form upon its completion.

WHEN man encounters a new form of energy, he at first uses it in the form provided by nature. Next, he proceeds to duplicate the natural phenomenon artificially in order to intensify or otherwise improve on the natural product. Finally, he builds machines for utilizing the new discovery. Thus it was with heat, light, and electric energy. Man's first notice of fire must have been a burning tree struck by lightning. At first he just watched it burn. Then he took a piece of the burning wood and put more wood on it, and had a campfire which proved to be a useful device. For a long time he had to wait for a "natural" fire in order to have a campfire. Finally, he learned how to make fire artificially whenever he wanted it by rubbing two sticks together, which was a great advance. Then followed matches, stoves, steam boilers, and internal combustion engines.

Nuclear energy was no exception. Its beginnings were made with no other source of high-energy particles than the positive ions, electrons, and photons emitted from natural radioactive nuclei as alpha, beta, and gamma rays respectively. Later, cosmic rays were added. In fact, for the very highest energies we still are dependent on cosmic rays, although man-made energies equalling the average cosmic ray of a few billion electron volts appear to be just around the corner.

The history of charged-particle accelerators may be said to begin with the evacuated tube and spark coil of W. K. Roentgen which accelerated electrons, and resulted in the discovery of X rays in 1895. This opened up a brand new field of research which was very active for about 40 years, during which time the extranuclear electrons of the atom were explored thoroughly, and now generally are considered to be well understood.

Nuclear physics also began at about the same time, when A. H. Becquerel discovered natural radioactivity in uranium in 1896. In comparison with X rays, however, nuclear research progressed much more slowly during the same period, caused primarily by the lack of machines for artificially generating the high-energy particles given off by the nucleus in natural radioactivity. Electrical technology just was not advanced enough at this time to produce the few million volts involved in nuclear reactions, although it could supply the hundred kilovolts needed to strip off the most tightly bound extranuclear electrons. This is not meant to imply that good work was not done in nuclear research with natural sources; in fact an amazing amount of excellent work was done, considering the feeble currents of positive ions and electrons available from natural sources of alpha and beta rays. However, the fact remains that the progress of nuclear research was accelerated tremendously when machines were devised which made possible artificial nuclear reactions.

TYPES OF ACCELERATORS

For convenience, charged-particle accelerators may be classified according to three groups; that is, according to the form of the machine, according to the principle used for obtaining the electric field, or according to the kind of particles accelerated. Each group will include two types.

In the first group, accelerators may be divided into two types which may be designated as linear and circular, for lack of a better distinction. In the linear type, charged particles move in a straight line while being pushed along by an electric field. The energy gained is proportional to the length of the machine times the voltage gradient. High energies, therefore, mean a high-voltage gradient, a long machine, or both. Examples of this type are the various d-c machines such as the Van de Graaff generator, and the different kinds of radio-frequency linear accelerators.

In the circular type, the particle travels many times around a path more or less resembling a circle so that the path length can be many times greater than the dimensions of the machine, and therefore the voltage gradient can be relatively small. However, this is not without its disadvantages, for something must be supplied to cause the particles to move in a circle. This something is ordinarily a large electromagnet, although in principle a suitably shaped d-c electric field could be used. The cyclotron, betatron, and synchrotron are examples of the circular type of accelerator. The linear and circular types also can be designated as the single-transit and multiple-transit types respectively, for obvious reasons.

In the second group, accelerators may be divided into two types, according to whether the accelerating electric field is a d-c static field, or an a-c electric field generated by a changing magnetic field. In the d-c class there are the transformer-rectifier machines, particularly the cascade rectifier, and the Van de Graaff electrostatic generator as typical examples. The d-c accelerators have the advantage of simple focusing, a steady beam current, a well-defined energy, and no orbit stability problems. However, in the d-c type, a high voltage always has to appear across a solid

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insulator somewhere. This has limited such machines to a few million volts.

On the other hand, with the a-c or nonstatic accelerators in which the required electric field is obtained directly from a changing magnetic field, it is not necessary to have any high voltage across solid insulation. For example, we can use what have been called "copper insulators," such as a quarter-wave stub line which will maintain a high voltage across itself while drawing very little current. Not being limited by insulator breakdown, much higher voltages may be obtained. Examples of a-c accelerators are the radio-frequency linear accelerators, the cyclotron, the betatron, and the synchrotron.

In the third group, particle accelerators may be divided into two types, according to whether they accelerate light particles or heavy particles. Light particles refer to electrons, although positrons could be accelerated equally well if there were any occasion to do so. The heavy particles of greatest interest are protons, deuterons, and alpha particles. Only in the case of the simplest accelerators, such as the cascade rectifier and the Van de Graaff generator, can the same machine be used to accelerate both light and heavy particles. Because of the effects of relativity, which says that no particle can move with a speed greater than the velocity of light, accelerators for heavy particles usually must be designed quite differently from those for electrons. In fact, accelerators for electrons cannot properly be called accelerators at all, for the acceleration is usually negligible. That is, the velocity is nearly constant and equal to the velocity of light. For example, at ten million volts, the velocity of an electron differs from the velocity of light by about one tenth of one per cent and at a billion volts, its speed is equal to the velocity of light within one part in ten million. What happens is that the electric field increases the mass of the electron instead of its velocity. For light particles, the name apponderator has been suggested to take the place of accelerator, but it does not seem yet to have become generally used. Hence, we may continue to call them accelerators without confusion, provided we remember that in practice they do not usually cause acceleration. Examples of accelerators particularly suited to light particles are the betatron, electron synchrotron, and electron linear accelerator.

In heavy-particle accelerators, the situation is much different. Because of its large rest mass, the particle travels at a variable velocity instead of a constant velocity so that the machines must be designed quite differently, even when they operate by the same method. Even at a billion volts, a proton is only moving at 87 per cent of the speed of light. The cyclotron, proton synchrotron, and proton linear accelerator are examples of heavy-particle accelerators.

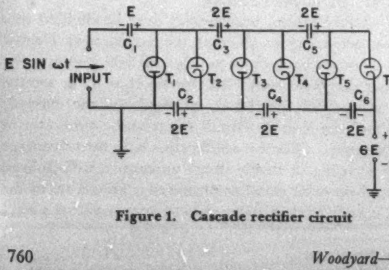

Figure 1. Cascade rectifier circuit

THE CASCADE RECTIFIER

After it had been shown that the nucleus of certain atoms could be broken up by alpha particles from natural radioactive sources, attempts were made to accelerate ions artificially to cause nuclear reactions. The first particle accelerator which was successful in producing such reactions was the cascade rectifier constructed by J. D. Cockroft and W. Walton[1] in 1930, using the arrangement shown in Figure 1, which illustrates the circuit for six stages.

The voltage multiplying action depends on the well-known fact that a half-wave rectifier with capacitor load, when fed by an alternating voltage of $E \sin \omega t$, develops an inverse-peak voltage of $2E$ across the rectifier tube. This fluctuating voltage across the first tube in turn may be rectified by another oppositely-directed half-wave rectifier and capacitor causing a direct voltage of $2E$ across the second capacitor and again an inverse peak voltage of $2E$ across the second tube, and so on.

For example, in Figure 1 consider first T_1 and C_1 alone, with all the other tubes and capacitors removed, and an a-c input voltage as indicated. This is an ordinary half-wave rectifier with capacitor filter and no load, so C_1 will charge to a voltage of E and the inverse peak voltage across T_1 will be $2E$. Now add T_2 and C_2 which rectifies the voltage across T_1. A direct voltage of $2E$ appears across C_2. By Kirchhoff's second law, the voltage across T_2 consists of a d-c component of E, plus an a-c component with a peak value of E so that the total peak voltage is $2E$. Addition of T_3 and C_3 then will rectify this voltage producing a direct voltage of $2E$ across capacitor C_3. This may be continued to as many stages as desired giving a d-c output voltage of nE where n is the number of stages. This analysis is for conditions of no load and the voltage will drop when a load is applied at the output of the last stage, but for very light loads the voltage will be very nearly the value calculated. Because the filaments in Figure 1 are at high potential with respect to ground, special provision must be made for heating the filaments, such as cascade transformers, insulated batteries, or a radio-frequency filament supply.

The high-voltage d-c output of the cascade-rectifier is fed into an evacuated accelerating tube illustrated in Figure 2. This tube consists of an ion source at the top, a stack of focusing rings across which the high voltage is applied, and a

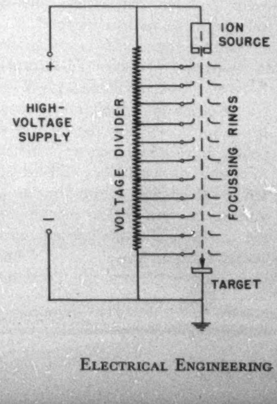

Figure 2. High-voltage accelerating column

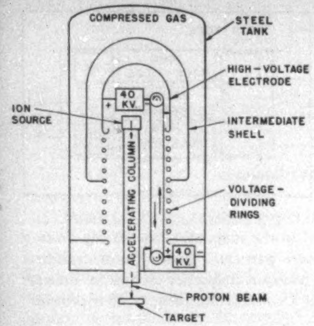

Figure 3. Electrostatic generator

target at the bottom. The voltage divider is necessary to equalize the voltage across the focusing rings. In actual practice, the voltage divider is frequently a series of corona gaps rather than a physical resistor. The ion source for protons consists of an arc in an atmosphere of hydrogen gas at a pressure of about one-tenth of a millimeter of mercury. The ions are drawn through a very small hole so that a good vacuum may be maintained in the accelerating portion of the tube across which the high voltage is applied.

The first machine constructed by Cockroft and Walton produced protons of 300,000 electron volts. A second machine completed in 1932 produced about 10 microamperes of protons at 800,000 volts. A large machine of this type for three million volts has been built by them.

THE ELECTROSTATIC GENERATOR

If an electric charge is carried mechanically to an insulated conductor and deposited thereon, the potential of this conductor is raised, and work is done in moving the charge against the electrostatic force caused by this potential. By repeating this process, the potential of the insulated conductor may be increased until it is limited by sparking. This is the principle of one of the earliest pieces of electric apparatus used in physics. The charge usually was carried by metallic conductors attached to whirling glass plates. Sparks up to two feet long were produced by the larger machines. A generation ago one or more of these "static machines" was found in the physics laboratory of nearly every university, and today they still will be found in the museums of many physics departments.

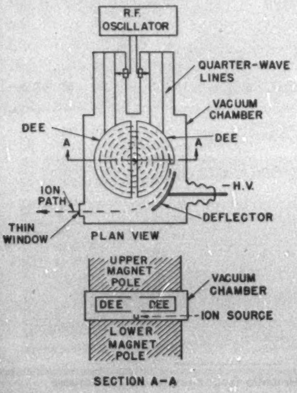

Figure 4. Accelerating electrode system of cyclotron

The early designs were poorly adapted to producing either a voltage sufficient for nuclear reaction or a steady output. The geometry was poor from the standpoint of corona and sparking, and the machines were self-excited. That is, the voltage built up from what small residual charge happened to be left on the insulated conductors. In 1931, R. J. Van de Graaff[2] constructed a machine which gave a steady output of 1.5 million electron volts and a current of 25 microamperes. Two metal spheres were used as high-voltage electrodes, because this is the most efficient shape for minimizing sparking, and a controllable amount of charge was sprayed onto moving belts which conveyed the charge to the high-potential spheres.

This design changed the electrostatic machine from a plaything into a practical source of high voltage, and has come to be commonly known as a Van de Graaff generator. By placing the whole machine in a strong steel tank filled with air at high pressure, higher voltages can be obtained because the dielectric strength of air is approximately proportional to pressure. Addition of a gas which has a strong tendency to form negative ions by electron capture further will increase the breakdown voltage. Freon gas commonly is used. Machines operating at pressures of more than 100 pounds per square inch and producing voltages in excess of four million electron volts are now in use.

A cross-section view of a modern Van de Graaff Generator is shown in schematic form in Figure 3. The accelerating column is similar to the one shown in Figure 2. Voltage dividing rings as shown are necessary to distribute the voltage uniformly along the supports for the high-voltage electrode. The electric power necessary for running the ion source and other equipment is transmitted as mechanical power up the same belt that carries the charge. One or more intermediate shells may be placed around the high-voltage electrode to make the voltage gradient between it and the tank walls more uniform.

Although the Van de Graaff generator does not produce what is considered a very high voltage nowadays, it has the great advantage, for some purposes, over other types of accelerators that all the particles have precisely the same energy, and this energy may be measured accurately. Also, the beam of particles is well collimated and of small diameter, and the entire beam easily can be brought outside the machine. In some of the circular types of accelerators it is very difficult to deflect a large fraction of the beam.

THE CYCLOTRON

To make high-energy particles with the accelerators described thus far, it is necessary to have a correspondingly high voltage between two points in the machine. To overcome this limitation a multiple-transit accelerator, later known as the cyclotron, was proposed by E. O. Lawrence. Such a machine was constructed in 1931 which delivered protons of 0.5 million electron volts with only 5,000 volts between the accelerating electrodes.[3]

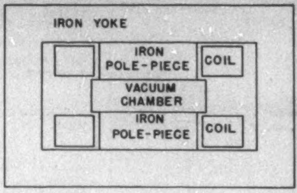

Figure 5. Magnetic circuit of cyclotron

Briefly stated, a cyclotron consists of two radio-frequency accelerating electrodes in a steady magnetic field with a resonance condition between the frequency of the applied voltage and the strength of the magnetic field. For this reason it at first was called a magnetic-resonance accelerator. The accelerating electrodes usually consist of two hollow D-shaped conductors (dees) as shown in Figure 4. Ions starting out from the ion source at the center are acted on by both an a-c electric field and a d-c magnetic field.

The principle of operation depends on the fact that a charged particle moving in a magnetic field alone describes a circular path with a rotation frequency which is independent of the velocity of the particle or the radius of the path, and which depends only on the strength of the magnetic field. This is true provided that the kinetic energy of the particle is small compared with its rest energy. By rest energy is meant the energy equivalent of the particle's rest mass or m_0c^2 ergs, where m_0 is the rest mass of the particle in grams and c is the velocity of light in centimeters per second.

The rotation frequency may be determined as follows. For any charged particle with any energy, from the theory of relativity

$$Br = \frac{m_0c^2}{e}\sqrt{\alpha^2+2\alpha} \qquad (1)$$

where

B = magnetic flux density in gausses
r = radius of path in centimeters
e = charge of the particle in electrostatic units
α = kinetic energy/rest energy

For an electron, proton, or deuteron, e is 4.80×10^{-10} electrostatic unit. For an alpha particle it is twice this. The rest energy is 0.511 million electron volts for an electron and 938 million electron volts for a proton so that α is just the particle's energy in million electron volts, divided by 0.511 for an electron or 938 for a proton.

Equation 1 is written in completely general form because it will be needed later, but when the kinetic energy of the particle is small compared with its rest energy, as is the case in the ordinary cyclotron, the first term under the square root drops out. Also, under these conditions, the kinetic energy becomes equal to its ordinary nonrelativistic value of $m_0v^2/2$ where v is the velocity of the particle in centimeters per second, and $\sqrt{2\alpha}=\beta$, where $\beta = v/c$. Equation 1 then becomes

$$Bre = m_0c^2\sqrt{2\alpha} = m_0c^2\beta \qquad (2)$$

The rotation frequency f in cycles per second is given by

$$f = \frac{v}{2\pi r} = \frac{\beta c}{2\pi r}$$

On substituting the value of β from equation 2, r cancels, giving

$$f_0 = B\frac{e}{2\pi m_0 c} \qquad (3)$$

where f_0 is the value of f when the kinetic energy of the particle is small compared with its rest energy. Equation 3 says that f_0 is equal to the magnetic flux density times a constant for any given particle. This type of cyclotron also is known as a constant-frequency cyclotron because the particles rotate at a constant frequency. For protons

$$f_0 = 1{,}530\ B \text{ cycles per second} \qquad (4)$$

With a flux density of 15,000 gausses, this corresponds to a frequency of 23 megacycles or a wave length of 13 meters.

As shown in Figure 4, positive ions are injected at low velocity into the space between the dees at the center of the magnetic field. Some of the ions receive energy from the radio-frequency field and travel outward in a spiral path with their kinetic energy increasing as the square of the radius, according to equation 2. When the ions reach the edge of the magnetic field, they pass through an opening in the side of the dee into a region where they are acted on by a negatively-charged deflector plate which pulls them out of the magnetic field. From here they pass out of the vacuum chamber through a thin aluminum window. Because of the magnetic field fringing between the electromagnet poles, the lines of flux are curved outward in such a way that an ion above or below the median plane will encounter a force like that on a current in a magnetic field, tending to bring it back toward the center. That is, there is a magnetic focusing of the ion beam in the vertical direction.

THE FREQUENCY-MODULATED CYCLOTRON

The constant-frequency cyclotron just described is satisfactory for protons up to 10 or 20 million electron volts, depending on the ratio of applied radio-frequency voltage to particle energy. When the kinetic energy is not sufficiently small compared with the rest energy of the particle, the first term under the square root in equation 2 is not negligible and the rotation frequency is decreased. This soon would cause the particle to get out of phase with the applied frequency and acceleration would stop.

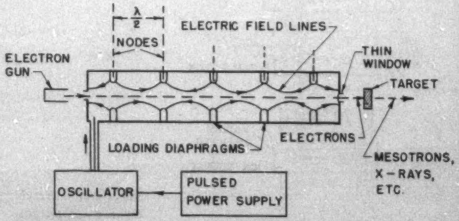

Figure 6. Electron radio-frequency linear accelerator

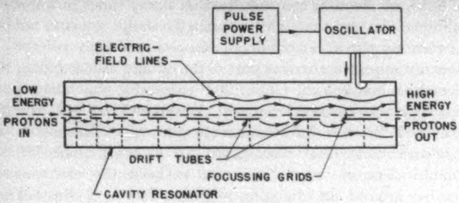
PULSE POWER SUPPLY
OSCILLATOR
ELECTRIC-FIELD LINES
LOW ENERGY
PROTONS IN
HIGH ENERGY
PROTONS OUT
DRIFT TUBES
FOCUSSING GRIDS
CAVITY RESONATOR

Figure 7. Proton radio-frequency linear accelerator

To overcome this effect, which results from the relativistic increase of mass, the frequency may be lowered as the particle moves out from the center.[4] This usually is done by modulating the frequency of the oscillator by means of a motor-driven variable capacitor, hence the name "frequency-modulated cyclotron."

The amount of this frequency reduction can be found as follows: Relativity shows that the kinetic energy of a particle is equal to

$$m_0c^2(G-1)$$

where

$$G=1/\sqrt{1-\beta^2}$$

so that

$$\alpha=\frac{1}{\sqrt{1-\beta^2}}-1 \qquad (5)$$

Rearranging equation 5,

$$\sqrt{\alpha^2+2\alpha}=\beta(1+\alpha) \qquad (6)$$

Substituting equation 6 in equation 1 gives

$$\beta=\frac{Bre}{m_0c^2(1+\alpha)}$$

and solving for f as before, and comparing with Equation 3

$$f=f_0\frac{1}{1+\alpha} \qquad (7)$$

which shows that the frequency is decreased from its low-energy value by a factor of $1/(1+\alpha)$. For example, with 469-million-electron-volt protons, α would be 0.5 so that a frequency decrease during acceleration of 33 per cent

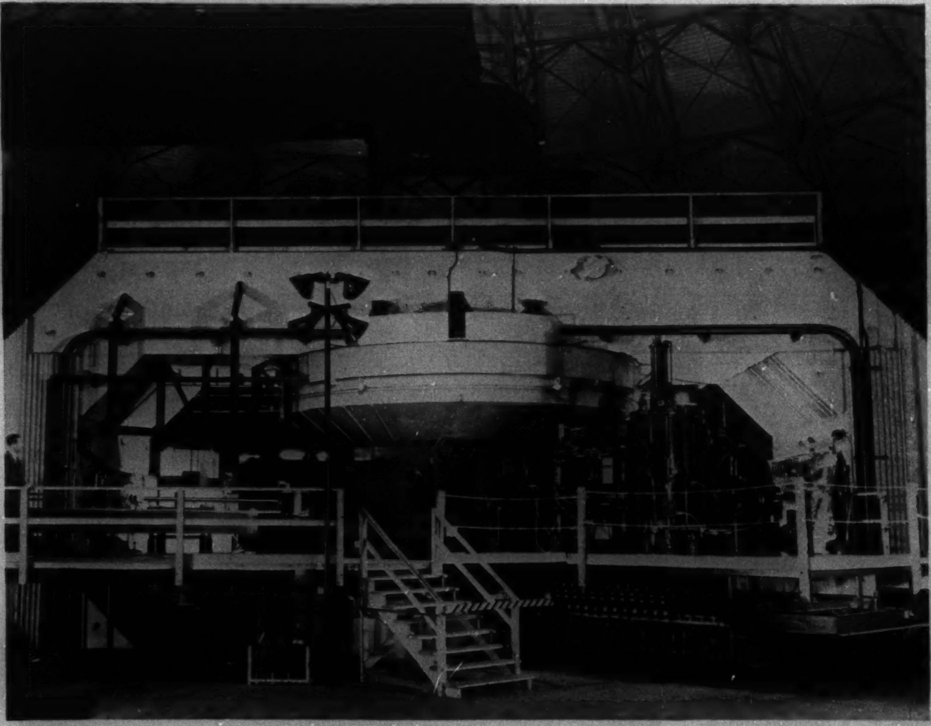

Figure 8. The 184-inch cyclotron at the University of California

of the initial frequency would be necessary. Actually, somewhat more frequency swing than this is provided in order to use a fairly straight portion of the frequency–time curve.

In principle it would be possible to have the magnetic field stronger at greater distances from the center instead of using frequency modulation, but this would mean that the flux lines would curve inward instead of outward, producing magnetic defocusing instead of focusing of the ion beam.

The frequency-modulated cyclotron sometimes also is referred to as a synchrocyclotron because of its resemblance to the synchrotron, which will be described later. The frequency-modulated cyclotron is capable of producing higher energy ions than the constant-frequency cyclotron, but its ion beam current is less because the beam comes out in pulses separated by a few milliseconds, while the constant-frequency cyclotron produces one output pulse for each radio-frequency cycle. Also it is more difficult to produce a deflected or external beam with the frequency-modulated cyclotron because the increment of radius per revolution is much smaller than in the constant-frequency cyclotron, which prevents the use of a simple d-c deflector as shown in Figure 4. This results from the fact that it is necessary to use a smaller radio-frequency dee voltage with frequency modulation because of voltage and speed limitations of the rotary capacitor. Deuterons of approximately 200 million electron volts and alpha particles of 400 million electron volts have been obtained by this method.[5]

THE BETATRON

The first of the machines particularly adapted to the "acceleration" of electrons was the betatron, so called because the early machines produced electrons with an energy comparable to the beta rays of radioactivity; however, modern machines produce energies of tens to hundreds of times those of beta rays. The betatron also sometimes is called an induction accelerator because it works on the principle of magnetic induction exactly as a transformer, in which the secondary winding is the circular electron orbit surrounding the changing magnetic flux.

Because the electrons travel at practically the velocity of light, an electron can link the flux many times in a few milliseconds, so that an exceedingly large number of "secondary turns" is obtained; however, a high voltage does not appear across any part of the circuit, thus avoiding electrical breakdown. The first successful machine of this type was constructed by D. W. Kerst[6] in 1940, and delivered electrons of 2.3 million electron volts. Since then machines have been constructed up to more than 100 million electron volts. In order to keep the electrons circling around the changing magnetic flux at a constant radius, a magnetic field is provided at the position of the orbit. If the flux density at the orbit increases with time in such a way that it is always one-half the average flux density inside the orbit, a radial focusing action will occur and the electron orbits will be stable. The ring of flux at the position of the orbit may be designated as the guiding flux, and the flux which lies inside of the orbit as the accelerating flux.

In machines thus far constructed, both the guiding flux and the accelerating flux are supplied by the same coils excited with alternating current at a frequency of 60 to 500 cycles. The magnetic circuit looks much like that of the cyclotron shown in Figure 5, except that the iron must be laminated because the magnetic field is alternating rather than steady, and the vacuum chamber is annular or doughnut-shaped, as the particles do not spiral out from

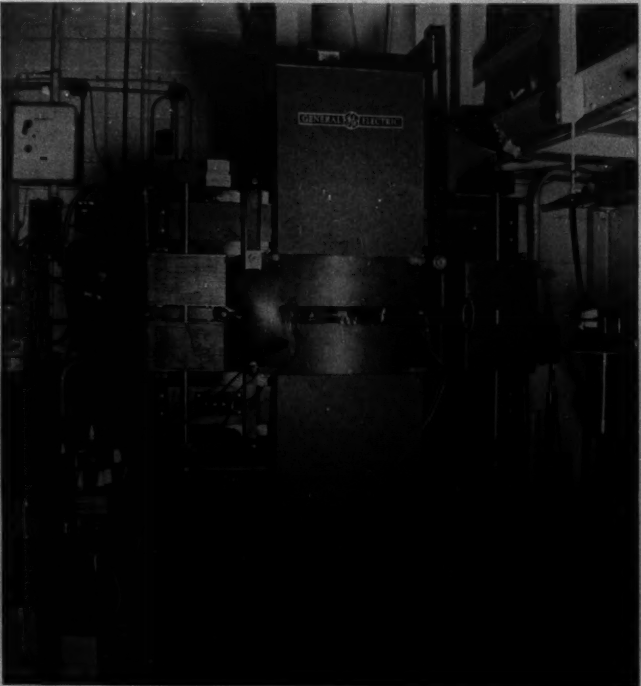

Figure 9. A 70-million-electron-volt synchrotron

the center, but remain near the outer edge of the field where they are injected by an electron gun.

For the same particle energy, a betatron magnet may be much smaller than a cyclotron magnet, but it is necessary to provide a large bank of capacitors for the betatron to correct the power factor of the a-c magnet, so that the total cost is not greatly different. High-voltage X rays are produced by placing a target near the beam and contracting or expanding the beam circle near the peak of the cycle.

SYNCHROTRONS, ELECTRON AND PROTON

These two machines represent the highest state of development in the magnetic resonance accelerator group, which includes all those machines making use of resonance between the frequency of a radio-frequency voltage applied to the particle and the natural frequency of rotation of the particle in a uniform magnetic field. As is usual in the case of the specialized machines, the electron and proton versions are so widely different as to require separate treatment.

The Electron Synchrotron. The electron version is a kind of "electron cyclotron" that has come to be known as a synchrotron. In accelerating an electron to one hundred million electron volts, for example, its mass would be increased approximately 200 times. It is not feasible to vary a frequency rapidly by a ratio of 200 to one as required by equation 7, so that the frequency-modulated cyclotron is not suitable. However, it is not difficult to vary a magnetic field by this amount.

Instead of letting the electrons spiral out from the center as in a cyclotron, they may be kept at an approximately constant radius by injecting them at a few hundred kilovolts with 80 or 90 per cent of the velocity of light. This has the important advantage that most of the iron may be left out of the center of the magnet, as it is only necessary to provide a ring-shaped field in the region of the electron orbit. Such a machine has been described by E. M. McMillan[7] and others. Because the electrons travel at approximately a constant radius, the radic-frequency accelerating electrode is made in the form of a hollow tube bent into a semicircle, instead of a D-shaped electrode, as in the cyclotron. The electrons are accelerated twice each radio-frequency cycle; once when they enter the tube, and once when they leave it. Phase stable bunches of electrons are produced in which the bunch crosses the

Figure 10. A 100-million-electron-volt betatron

accelerating gap at a time when the radio-frequency accelerating voltage is on the decreasing part of its cycle. To see that the bunch is stable, consider an electron that crosses the gap too early. This electron will receive more energy than the average which slightly will increase the radius of its orbit causing it to take longer to get around so that it picks up less energy the next time. Thus any slight displacement in phase tends to be self-correcting.

Not only must the iron of the magnet for the electron synchrotron be laminated as in the betatron, because the magnet current is alternating instead of direct, but the radio-frequency accelerating electrode system must be laminated, or otherwise arranged, to prevent flux distortion by eddy currents in the electrode. Because the arrangement used to prevent the flow of low-frequency eddy currents must not interfere with the flow of radio-frequency currents, the accelerating electrode system becomes quite complicated.

The oscillator wave length is simply the circumference of the electrode orbit because the electrons travel at essentially the velocity of light. For example, if the final radius is one meter, the oscillator wave length is 6.28 meters, corresponding to a frequency of 47.7 megacycles. Assuming a maximum flux density of 10,000 gausses and substituting these values of B and r in equation 1, the solution for α gives a value of 586 which corresponds to a final energy of 300 million electron volts. For the same energy, the electron synchrotron has the advantage of requiring less iron and a smaller capacitor bank is compared with betatrons of the type in use at present.

The Proton Synchrotron. Here things are still one stage more complicated. Not only must the magnetic field vary from, say, 0 to 10,000 gausses, but the frequency must vary by something like a ratio of ten to one, even if the protons are injected at several million volts. The reason is that protons still are being accelerated at one billion volts, where they are only moving at 87 per cent of the velocity of light. It is feasible to vary the frequency this much because the acceleration takes a relatively long time, on the order of one second instead of about one hundredth of a second as in the betatron and electron synchrotron, so that motor-driven tuning devices can be used. Because the orbit radius is substantially constant, the frequency increases with time during acceleration instead of decreasing as in the frequency-modulated cyclotron.

The proton synchrotron also has been called a bevatron, from the abbreviation bev for billion electron volts, because it is specially adapted to accelerating protons to the billion-electron-volt range. Because the acceleration takes a relatively long time, the field rises so slowly that very thick laminations can be used. This is fortunate as the cost of a few thousand tons of transformer-grade steel probably would be prohibitive.

RADIO-FREQUENCY LINEAR ACCELERATORS, ELECTRON AND PROTON

In the cyclotron and synchrotron, a very large and expensive magnet is required to keep the charged particles moving in a circular path. This may be eliminated by letting the particles travel in a straight line instead of a circle; at the expense, however, of a large increase in the amount of radio-frequency power required because the same accelerating field is not used over and over again as in the multiple-transit circular accelerators. A few years ago the power requirements alone were sufficient to prevent the linear accelerator from competing with the other methods. However, wartime developments in high-power pulsed radar completely changed the situation. It is now possible to obtain peak power thousands to millions of times greater, depending on the frequency, than before the development of radar. With the high frequencies now available, it is also feasible to make use of the highly efficient cavity resonator and wave guide to build up as much voltage as possible.

Because of the large mass difference between electron and proton, the two accelerators are so different in structure and operation as to require separate treatment. The electron linear accelerator is perhaps simpler since the electrons travel at a constant velocity, as a first approximation.

The Electron Linear Accelerator. Consider a long cylindrical wave guide closed at each end so as to form a cavity resonator, and driven by an oscillator of the proper frequency to excite the axial electric (0, 1, n) mode where n is a large number, also sometimes called the TM (0, 1, n) mode. This field could be used to accelerate electrons traveling along the axis, except that the nodes are always slightly more than half a free-space wave length apart, which would require that the electrons travel slightly faster than the velocity of light. Of course, electrons cannot travel faster than light, but the phase velocity of the wave can be slowed down to the velocity of light, or even a little less, if desired.

This is done by putting a number of constrictions or iris diaphragms along the inner surface of the cylinder, as shown in Figure 6, which illustrates an accelerator using the (0, 1, 5) mode. In practice n is much larger than 5, usually of the order of a hundred or more. The number of constructions must be two or more per wave length. Figure 6 illustrates standing waves, but traveling waves may be used. Such an accelerator has been described by W. W. Hansen and others.[8-10] A pilot model nine feet long has produced 4.5-million-electron-volt electrons when driven by a 10-centimeter magnetron delivering 0.75 megawatt peak power.

No electron focusing is needed to steer the beam down even a long tube, contrary to what might be expected. For example, with a tube 100 feet long on a wave length of ten centimeters producing electrons of 10^9 electron volts, the Lorentz contraction because of relativity is so great that the tube appears only 4.2 inches long to the electron. So how could it miss the hole at the far end? For calculations, see page 94 of reference 9.

The Proton Linear Accelerator. With protons, different tactics must be used. Even if they are injected at four million electron volts, protons are moving at only one-tenth the velocity of light, and it is not practical to slow down the phase velocity of a wave this much by loading as described for electrons. Instead, an entirely different mode is used, best described as derived from the *TEM* mode between parallel planes short-circuited by a cylindrical conductor. This gives a long cylinder with an axial electric field all in phase no matter how long the cylinder.

A proton injected along the axis would experience no net acceleration because the positive and negative half cycles would cancel. However, by placing a series of small drift tubes along the axis to shield the proton during the decelerating half of the cycle, a large acceleration will be obtained. A schematic diagram of such a machine is shown in Figure 7. In practice many more drift tubes than shown are used.

In order to have phase-stable bunches of protons it is necessary that the bunch cross the accelerating gap during the time of the cycle when the accelerating voltage is increasing. Then a proton which arrives a little late will receive a larger voltage increment and will go faster than average and therefore will tend to catch up. However, particles crossing the gap during the phase-stable part of the cycle will be strongly defocused by electron lens action and would be lost from the beam. To overcome this, a strong focusing action is obtained by putting a focusing foil or grid to cut out the defocusing half of the field in one end of each drift tube as shown.

An accelerator of this type constructed at Berkeley, Calif., has been described by Alvarez.[11] Using a cavity resonator 40 feet long operating on 205 megacycles with a peak power of 2.5 megawatts, protons with an energy of 32 million electron volts were obtained.[12] The protons were injected from a 4-million-electron-volt Van de Graaff generator.

SUMMARY

Four basically different kinds of machines for producing high-energy charged particles in the energy range from a million electron volts up to perhaps ten billion electron volts have been described. These four are the d-c machines, the magnetic resonance accelerators, the magnetic induction accelerator, and the radio-frequency linear accelerators.

The d-c machines, of interest chiefly for the lower voltages, include two types, the cascade rectifier and the electrostatic generator. The magnetic resonance group, which has been the most highly developed to date, includes four machines; the constant-frequency cyclotron, the frequency-modulated cyclotron, the electron synchrotron, and the proton synchrotron. Magnetic induction accelerators include only one example, the betatron. The radio-frequency linear accelerators include two quite different machines; the electron linear accelerator, and the proton linear accelerator.

One trend should be noted. The machines of modern physics, particularly nuclear physics, are tending to become more and more of an engineering magnitude and engineers trained in the field will be needed. A few years ago a physics experiment was something which was set up on a table in one room. Today the largest machines contain thousands of tons of iron and hundreds of tons of copper, and machines of 100,000-kva rating seem not far away.

Progress toward higher energies has been rapid and steady. During the past 25 years, the voltages attainable have increased rather uniformly by about a factor of ten every six years. What the future holds we only can guess, but if the past is any indication, we will be well beyond the billion-electron-volt range in another ten years.

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A New Particle

Strong experimental evidence for the existence of a new particle was presented in the form of a photograph of cosmic ray phenomena taken in the Swiss Alps in Europe at a symposium on cosmic rays held at California Institute of Technology, Pasadena, Calif., according to the *New York Times* (June 21, 1948). The symposium was held in honor of Doctor Robert A. Millikan, dean of American physicists and winner of the Nobel prize for his measurement of the charge of the electron. The photograph, shown by Doctor Louis Leprince-Ringuet, French physicist of the University of Paris, indicates the existence of a fundamental particle with a mass greater than 750 and possibly as high as 900. The new particle belongs to the family of cosmic ray products known as mesons or mesotrons. These mesons are believed to be the result of the interaction between the primary cosmic rays originating in interstellar space and the nuclei of atoms in our atmosphere.

Discovery of the latest fundamental particle among the basic building blocks of the universe brings the total of such particles to 12, plus the photon, an energy particle originally suggested by Einstein. It is interesting to note that only three such particles were known in 1936. These particles, with their charge and mass, are listed as follows:

Particle	Charge	Mass
Electron	minus	6
Proton	plus	1831
Neutron	zero	1836
Positron	plus	1
Light meson	plus	200
Light meson	minus	200
Heavy meson	plus	320
Heavy meson	minus	320
Super heavy meson	plus	900
Super heavy meson	minus	900
Neutral meson	zero	88
Neutrino	zero	zero
Photon	zero	zero

A "Superimposed Frequency" Motor Test

M. P. ROMEIRA

FEEDING 3-PHASE currents to the slip rings of induction motors at slip frequency for speed regulation or phase advancing (power factor improvement), or at any other frequency for other purposes is used frequently and the principle is well known. Another possible application of this principle is that of testing induction motors under full current loading conditions, while running at full speed, with the stator supplied at full voltage and frequency, and without the use of any kind of loading machine. This results in a large saving of energy because the run is taken at near zero power factor for primary and secondary supply.

Figure 1 shows the necessary plant and connections; T_s is the secondary of the test transformer, supplying full voltage and frequency to the stator *S* and to the primary of a voltage regulator *VR* whose output side is connected through a water resistor *WR* to the slip rings of the rotor *R* of the motor under test. The voltage regulator set (preferably including an auxiliary multiwinding and tapped transformer to extend the range of application) should be able to regulate the supply voltage (from T_s) between zero and 25 per cent of the highest expected open circuit rotor voltage.

Two sets of measuring instruments (W_1 and W_2) are connected in the stator and rotor circuits respectively; and running up the motor to full speed under full voltage and frequency, we inject into the rotor a low voltage of normal frequency whose phase rotation is such as to induce a double frequency voltage e in the stator winding, which is superimposed on the applied voltage E to give a resultant E_R as shown in Figure 2. The stator current increases and can be adjusted to any desired value by first cutting out the resistor *WR* and then adjusting the injected voltage on the regulator *VR*. It generally will be found that both stator and rotor currents are balanced perfectly and the wattmeters W_1 and W_2 read respectively the no-load losses and the copper losses of the motor. The power factor for W_1 is the same as it is under no-load conditions and for W_2 it is the same as that obtained under locked rotor conditions.

This test was developed primarily as a heat run; but the motor efficiency and other required data can be obtained at the same time, directly from the readings of W_1 and W_2 subject to the application of certain easily obtained correction factors. Thus the no-load losses W_1 may appear slightly increased because of the presence of the secondary of the voltage regulating set *VR* in the rotor circuit, and the somewhat distorted wave shape of E_R (Figure 2) resultant of the applied voltage to the stator E and the double frequency induced voltage e. This is really immaterial, as the actual no-load loss is taken with the slip rings short-circuited. Also, the copper loss reading W_2 may be expected to be somewhat high, because it includes the loss caused in the cable and secondary of the supply transformer T_s as well as a possibly higher eddy current loss. These differences however are not considerable, if as usual the rating of the test equipment is large compared with the motor to be tested, and in any case can be worked out once for all and taken care of by adequate correction factors.

The following results obtained with a 50-cycle 40-horsepower motor will indicate the degree of accuracy to be expected, though no special care was taken with the readings or any corrections applied. The motor name plate data includes the following information: for the stator, 380 volts, 52.3 amperes; for the rotor, 150 volts, 93.0 amperes; and 725 rpm. The following tests were taken:

(*a*). No-load: $V_1=380$; $A_1=12.5$; $W_1=1.125$ kw; $\cos\phi_n=0.136$.

(*b*). Locked rotor: $V_1=78$; $A_1=50.0$; $W_1=3.2$ kw; $\cos\phi_s=0.476$.

(*c*). *SF* test: $V_2=30$; $A_2=123$; $W_2=3.02$ kw; $\cos\phi_s=0.472$.

The subscripts 1 and 2 refer to readings taken on the primary or secondary respectively; and *SF* is the superimposed frequency test. The locked rotor test was taken for comparison purposes; and from it we get the full voltage short-circuit current $I_s=243.5$ amperes. From the *SF* test we get $I_s=243$ (referred to stator). The no-load readings (*a*) were found to remain constant when the *SF* test (*C*) was applied, and the speed unaltered; then clearly (W_2) must represent the copper loss at the stator load taken (51 amperes). These results show that there was no appreciable difference between the *SF* and the locked rotor tests.

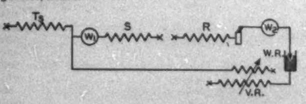

Figure 1. Schematic diagram of test setup

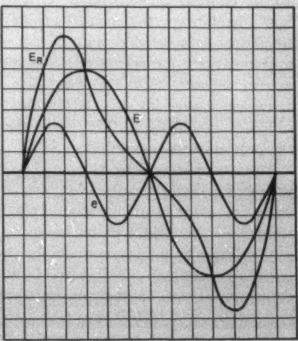

Figure 2. The normal frequency voltage E supplied to the stator combines with the double frequency voltage e induced by the rotor double speed flux giving a resultant voltage E_R whose peaked wave form may affect the iron loss

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Digest of paper 48-133, "The 'Superimposed Frequency' Test For Induction Motors," recommended by the AIEE rotating machinery committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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Low-Voltage Arcing-Fault Currents

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One method used in the selection of circuit breakers for application to low-voltage a-c circuits is based on the assumption of "bolted" faults. Some engineers, however, believe that these fault currents never are reached in practice. An extensive series of tests shows a distinct need to clarify the situation in so far as the effect of arc drop is concerned.

THE recommended AIEE method[1] of calculating short-circuit currents in circuits of 600 volts and below is based upon the assumption of a "bolted" fault. Circuit breakers applied to such circuits are rated on the maximum value of the average rms currents in the three phases. The effect of dissymmetry is included by multiplying the symmetrical short-circuit current for the bolted-fault condition by the factor 1.25 which then gives the average current in the three phases. This corresponds to a short circuit in which maximum dissymmetry occurs in one phase, and the X/R ratio of the circuit is 11.8. The rms current in the phase of maximum dissymmetry is 1.48 times the rms symmetrical current. Some engineers believe that the fault current calculated upon the basis of a bolted fault is inordinately high and that such values are not obtained in practice. Whether this be true or not is dependent to a large extent upon the nature of the fault, upon how the faults are initiated, and upon the effect of the fault arc in limiting the short-circuit current.

In 1941, O. R. Schurig[2] presented data on the effect of fault voltage drops and impedances upon the short-circuit currents in low-voltage circuits. In his synopsis, the statement appears that "Instances are shown where actual fault currents reach 100 per cent of the rms symmetrical values calculated for bolted faults." In his conclusions, the following statement appears "The current-limiting effect of accidental arc faults in low-voltage bus structures may be of a minor order, arc fault currents as high as 88 and 100 per cent (average 3-phase values) of the rms symmetrical bolted-fault short-circuit current having been obtained in tests at 300 volts and 600 volts line-to-line, open-circuit voltage, respectively." These figures represent a reduction from the bolted-fault factor of 1.25 to an arcing fault factor of 0.88 or 1.0. Schurig in a footnote recognizes this effect as representing a reduction to 70 and 80 per cent for 300- and 600-volt circuits, respectively, as compared to a bolted fault.

Without attempting to specify the conditions under which various types of electric apparatus should be applied to low voltage circuits, there appears to be a distinct need to clarify the situation insofar as the effect of arc drop is concerned. An investigation of this subject is in progress by the working group on calculating short circuit currents in low-voltage systems of the AIEE switchgear committee. As a contribution to this activity, the Westinghouse Electric Corporation undertook the tests described here. These tests were made in standard metal-enclosed bus structures, the short circuit being initiated by fusing copper wires and by metal objects resting across the bus conductors. Various sizes of fuse wire were used to determine what effect this might have upon the current. Naturally as the size of the wire is increased, the conditions of a bolted-fault are approached.

RESULTS OF PRESENT TESTS

The present observations may be summarized as follows:

1. On 250-volt and 125-volt a-c circuits, arcing faults are unstable and will extinguish themselves within two cycles or less even when initiated by four number 8 copper wires on a bus with 4-inch spacing. On busses with less than 4-inch spacing, it would be expected that the arc would have more of a tendency to stabilize itself.

2. About half of the line-to-line arcing faults on the 500-volt circuit were unstable and extinguished themselves.

3. The magnitudes of the first-half-cycle values of current are dependent upon the means of initiating the fault. In using a relatively small wire for the initiating means, the current as compared to the volted-fault current decreases as the circuit current level is increased. On the 500-volt circuits, the results of tests using copper and steel bars indicate that a factor of 0.9 might be applied to the bolted symmetrical current for systems whose bolted-fault currents are in excess of 40,000 amperes and a factor of 1.0 for systems whose bolted-fault currents

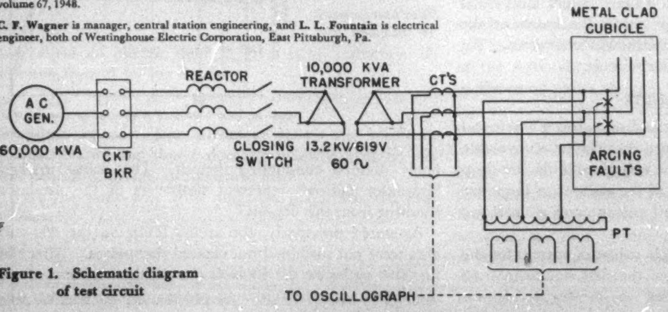

Figure 1. Schematic diagram of test circuit

Essential substance of paper 48-26, "Arcing Fault Currents in Low-Voltage A-C Circuits," recommended by the AIEE industrial power systems, switchgear, and transmission and distribution committees, and approved by the AIEE technical program committee for presentation at the AIEE winter general meeting, Pittsburgh, Pa. January 26–30, 1948; and scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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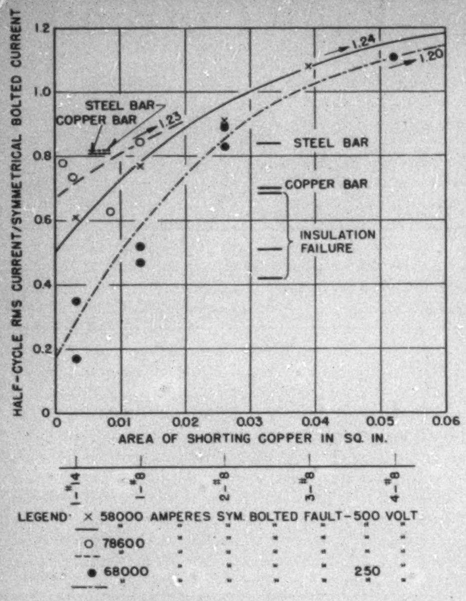

Figure 2. First half-cycle rms current as affected by nature of initiating means

are less than 40,000 amperes. On 250-volt circuits, the factor appears to be smaller.

4. On 500-volt circuits, the sustained currents may be less than 0.8 of the bolted symmetrical currents.

DESCRIPTION OF TEST

Standard bus construction and supports were used. Figure 1 is a schematic diagram of the circuit used. Power was supplied from a 3-phase source through cables. The open circuit voltages of the circuits were adjusted to 500, 250, and 125 volts. As determined from the bolted-fault tests, the X/R ratio of the circuit was 11.8.

The circuit was adjusted approximately to give a "nominal" value of current. For each "nominal" setting, tests were made with a bolted fault. The "bolted fault" was made by lamping copper straps across the busses at the same point at which the fuse wire was connected. An oscillogram was taken of each short circuit.

TEST RESULTS

As is characteristic of an arc, the drop across it was found to be quite variable. As the arc drop is an appreciable fraction of the circuit voltage, the variations in the arc drop are reflected in the magnitude of the current, a large arc drop tending to produce a small current and a small arc drop, a large current.

To determine the first half-cycle values of current for the arcing fault, the peak current of the first significant half cycle in each of the three phases was measured. It was then assumed that these half cycles of current were of sinusoidal wave shape. Two groups of tests were made several months apart.

In many of the tests, the arc extinguished and cleared the circuit before tripping of the circuit breaker which was set for a time of 10 cycles. All the 3-phase tests at 500 volts hung on and all the 250-volt tests both single-phase and 3-phase cleared without the circuit breaker opening. The results with single-phase 500 volts were mixed.

For a given condition of initiation, the ratio of the first half-cycle arcing current to the bolted-fault current generally decreases as the bolted-fault current is increased.

A large number of points were taken with the circuit impedances set to give 68,000 amperes and 78,600 amperes for the symmetrical bolted condition at 500 volts and to give 58,000 amperes at 250 volts. Different sizes of copper wire were used to initiate the faults. In Figure 2, the results of the tests for these three conditions are plotted against the area of the short-circuiting copper. The figures with the arrows indicate the magnitudes of the currents for the bolted-fault condition corresponding to the respective circuits. With very large wire, the fusing time becomes so long that bolted conditions are approached.

Likewise in the figure are plotted the first half-cycle values of current when the fault is initiated by a copper or steel bar resting across the busses. These values are indicated by short heavy horizontal lines whose relations to the abscissa have no significance. In all cases, the bars were thrown from their positions violently. These values lie intermediate between the values obtained for small and for large wire. After a large number of tests, the interior of the structure and the insulators became covered with a finely divided conducting deposit. The points marked "insulator failure" represent flashovers of the insulator resulting from this deposit.

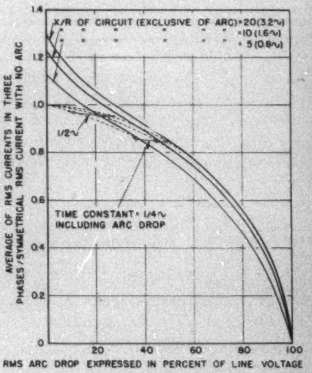

Figure 3. Effect of arc drop upon average rms current in three phases at end of first half cycle (including asymmetrical component)

Dotted lines symmetrical component only

As stated previously, the arcing faults on the 250-volt tests were not sustained but cleared themselves. After the first two cycles on the 500-volt circuit, the transient effects associated with the initiating process appear to have disappeared. The currents thereafter are dependent upon the impedance of the circuit and the arc drop.

As another approach in determining the effect of the arc on limiting the current, the arc voltage was measured for each half cycle between the third and sixth cycles. These values lie in general between 0.4 and 0.6 of the line voltage which in this case was 500 volts.

As a means of reflecting the effect of the arc drop upon the average rms current in the three phases, the curves in Figure 3 were computed. The abscissa expresses the arc drop as a per cent of the line voltage. The dotted lines and their continuation into the full lines give the symmetrical component of the current as a fraction of the symmetrical component of current with no arc (bolted fault) for three assumed ratios of reactance to resistance of the metallic portion of the circuit. The small circles on the dotted lines indicate the time constant of the circuit including the arc drop as a resistance drop. These in turn provide the medium to determine the extent by which the currents should be increased to include asymmetry. For arc drops between 0.4 and 0.6 of the circuit voltage, the curves of Figure 3 indicate that for the arcing fault condition, the average rms currents should lie between about 0.7 and 0.9 of the symmetrical current assuming that the fault developed into an arcing fault instantly.

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Electrical Essay

Diamagnetic Hysteresis in an Imperfect World

THE Pessimist: "There is nothing perfect in this imperfect world, and this universal truth is well brought out by the imperfect machines of electrical engineering. Our conductors are imperfect, giving rise to copper loss.

"Our insulating materials, by taking on electric polarization, P, in an electric field E, give us an induction D, differing from E by the equation

$$D=E+4\pi P$$

But when we try to take advantage of this and construct a capacitor, we find that P does not follow E exactly, but lags behind it, giving us dielectric loss.

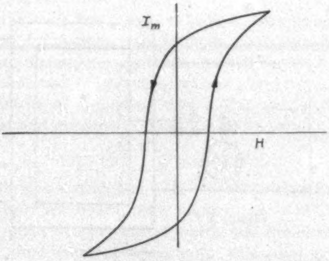

Figure 1

"It's the same way with magnetic materials. In iron we have

$$B=H+4\pi I_m$$

where I_m is the magnetic moment per unit volume. However, in use, we have hysteresis. As in Figure 1, I_m lags behind H, being less for H on the way up, than it is for H on the way down. So, hysteresis losses!

"So far, we do not make much use of diamagnetic materials. But when we do, you may be sure that diamagnetic hysteresis will make its appearance. The diamagnetic moment, I_d, will not follow the magnetic field H perfectly, but will lag it, even if only by a small amount. Yes, you can count on diamagnetic hysteresis."

Is the pessimist right? Is there a diamagnetic hysteresis?

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Answers to Previous Essays

The following are the authors' replies to the two electrical essays published in *ELECTRICAL ENGINEERING* for July 1948, pages 653–4.

I. INDUCTION MOTOR ABOVE SYNCHRONOUS SPEED

The conclusion is false. The induction motor above synchronism continues to operate at lagging power factor.

The error arises in not observing that the phase sequence of the rotor voltages relative to the rotor itself, reverses as the rotor passes through synchronism. Currents which lag the rotor voltages relative to the rotor itself, lead the rotor voltages when referred to the stator.

Perhaps this can be seen best by considering the secondary (rotor) as at rest, and the primary (stator) connected to the line, as in motion. Then just below synchronism, the magnetic field is rotating slowly through the secondary winding, say in a counter-clockwise sense as in Figure 2. A lagging polyphase secondary current will be related to the secondary voltage in its space distribution as shown by the arrows in Figure 2. However, above synchronism, the motion of the magnetic field relative to the rotor reverses, Figure 3. At the same time, the space distribution of the lagging current becomes as in Figure 3, opposite to that of Figure 2.

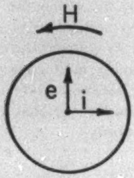

Figure 2

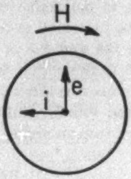

Figure 3

We see then, that in going through synchronism, there is a double reversal in the reactive current induced in the stator. First, there is a change of sign due to the change in sign of the rotor voltage e_2 which acting on $\mathcal{Z}$ gives the rotor current $e_2/\mathcal{Z}$. Then there is a change of sign due to the change of phase sequence in the rotor as shown in Figures 2 and 3. Hence there is no net change in sign of the reactive power taken by the stator as the rotor passes through synchronism.

When above synchronism, slip equal $-s$, the rotor impedance

$$\mathcal{Z}=R+jX$$

when referred to the stator, does not transform into

$$\frac{1}{-s}\left(\frac{n_1}{n_2}\right)^2 \mathcal{Z}$$

but into

$$\frac{1}{-s}\left(\frac{n_1}{n_2}\right)^2 \bar{\mathcal{Z}}=\frac{1}{-s}(R-jX).$$

J. SLEPIAN (F '27)
(Associate director, Westinghouse Research Laboratories, East Pittsburgh, Pa.)

Editor's Note: Unfortunately a number of printer's errors appeared in Doctor Slepian's electrical essay last month, the solution for which appears above. These are listed as follows:

Near the end of the second column on page 653,

$e_1 i_1=\frac{e_2}{s}$ should read $e_1 i_1=\frac{e_2 i_2}{s}$.

Near the top of the first column on page 654,

$\frac{1}{s}\left(\frac{n_1}{n_2}\right)2(R+jX)$ should read $\frac{1}{s}\left(\frac{n_1}{n_2}\right)^2(R+jX)$.

Finally, near the end of the first column on page 654,

$I_1{}^1=-I.$ should read $I_1{}^1=-I_1$.

II. MEASURING LEAKAGE REACTANCE

As the two windings have the same number of turns there will be no mutual flux linking them when they carry the same current. As soon as the voltmeter is connected across one winding it draws some current even though the amount happens to be too small to produce an observable deflection. Now the currents in the windings differ by the amount of the voltmeter current. Hence the voltmeter current becomes an exciting current in one winding. This exciting current produces a mutual flux that induces equal electromotive forces in the windings. It happens that the phase position of the electromotive force is such as nearly to compensate for the resistance and leakage reactance drops in the winding across which the voltmeter is connected and the terminal voltage of that winding becomes very small.

Another explanation that gives a better idea of the voltmeter current to be expected can be obtained by the application of Thevenin's theorem. Refer to Figure 4. If the coils are assumed to be similar the voltage between the points *A* and *B* will be *V*/2.

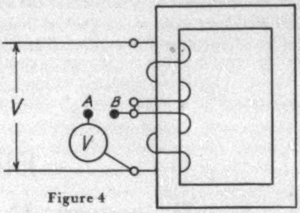

Figure 4

Now refer to Figure 5. With the source of voltage short-circuited, the impedance between the points *A* and *B* is equal to the resistance R_v of the voltmeter plus the impedance $\mathcal{Z}$ of the two windings in parallel *aiding*. Because of the iron core $\mathcal{Z}$ is nonlinear and cannot be combined directly with *R*. However, as an approximation we can say that the voltmeter current I_3 when the points *A* and *B* are connected is

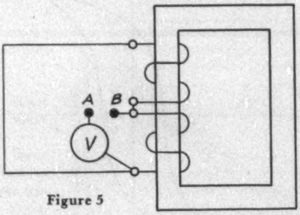

Figure 5

$$\dot{I}_v=\frac{\dot{V}/2}{R_v+JO+\dot{Z}}$$

From this equation it can be seen that $\mathcal{Z}$ may be the predominant factor in determining the value of I_v. For the particular transformer tested it was found that with the coils in parallel an applied voltage of 220 produced an exciting current of 0.4 ampere. The corresponding impedance is 550 ohms. At low voltages the impedance should be of about this same magnitude, so the voltmeter current is less that 3 volts÷550 ohms=5.5 milliamperes. This small current was not enough to register on the voltmeter.

GEORGE V. MUELLER (M '35)
(Professor of electrical engineering, Purdue University, Lafayette, Ind.)

The Paper Industry in Mexico

JOSE DE LA MACORRA, JR.
ASSOCIATE AIEE

A BRIEF SURVEY of the history of paper making in Mexico takes us back to the civilization existing before Cortés. The original races Mayas, Nahoas, Zapotecas, and Tarascas, made sheets of paper from "cactus" and "amacuahuitl." At the beginning of the conquest, the Spaniards used the paper they brought with them, and later when they needed greater quantities, they installed a small paper mill close to the "Gran Tenoxtitlán." Later, in the colonial period, the first printing shop in America was installed and during the years 1550 to 1600 the different monastic orders printed more than 100 religous works on paper coming from Spain.

The increasing demand for paper resulted in the installation of a paper mill in Mexico in 1649 while Pedro de Castro Figueroa was viceroy. In the year 1722 the first periodical publication in Mexico appeared, called the *Gazette of Mexico*.

The 19th century was the beginning of the insurrection of the American countries colonized by Spain, and then with their own nationality, the history of the Mexican paper industry started when Don José María Manzo founded a mill in the city of Puebla in the year 1822. In 1840 the Belem mill was constructed, and later in 1894 the San Rafael mill was started up with a production of seven tons per day, thereby initiating the modern manufacture of paper in Mexico.

Later the mills Progreso Industrial, Loreto, Peña Pobre, Coyoacan, La Aurora, and so forth, were founded, and when the Atenquique mill was started up in 1947 the country then had 14 important mills making practically all known grades of paper and constituting one of the most important and progressive industries of Mexico.

THE PRESENT INDUSTRY

According to statistics, in 1946 Mexico produced 118,000 tons of paper and board, using approximately 117,700 tons of wood pulp, 50 per cent of which was imported. The national production of wood pulp amounted to 56,900 tons. Furthermore, there were consumed some 20,000 tons of rags and waste paper by the national paper industry in the same year. In addition to the tonnage produced by the Mexican mills, there were imported 15,000 tons of paper of various grades, 54,000 tons of news print, and about 14,500 tons of kraft paper.

It is estimated that this year, Mexico will consume more than 200,000 tons of paper of all grades and that this figure will increase constantly as a consequence of the campaign against illiteracy which the government is conducting with great success throughout the nation. The gradual development of the newspaper business and the constant industrialization of the country obtained by the support which the government authorities have lent to the electrification of the national territory, and the vigorous initiative taken by Mexican investors will increase the demand for paper.

During the last seven years the Mexican paper mills have prepared to meet this increasing demand for paper. Skillfully overcoming the many critical difficulties during the war years it is estimated that more than 60 million Mexican pesos were invested in the renovation, expansion, and construction of mills for cellulose, mechanical wood pulp, caolin mining and washing, and preparation of paper sizing material; in installing modern systems for defibration of wood pulps and for stock treatment; new paper machines; in planning and installing new units for the generation of electric energy and in organizing technical and managerial systems adequate for the modernization of the industry. As a result of this investment, Mexico can count on paper mills which are on a level with the best in the world, and which can supply the national market with high quality papers.

PLANS FOR THE FUTURE

In the San Rafael mill a new paper machine is being installed at present, also the first plant in the world for making kraft cellulose by a continuous method. During this year the erection of an important mill in Tlalnepantla will be finished, which will manufacture varieties which at present are being imported, and soon another mill will be in operation in Monterrey.

The combined production of these new mills and of those already existing will exceed, according to estimates, 200,000 tons annually.

In speaking of the Mexican paper industry the difficulties obtaining the raw material for paper making, wood, should be considered. Most of the forests in Mexico are to be found in extremely mountainous districts, and are practically without means of transportation.

Because of these factors, the companies Loreto y Peña Pobre, Atenquique, and San Rafael have created special organizations with the name "Unidades Industriales Forestales," approved by the Mexican government, and have undertaken the task of simultaneous exploitation and reforestation. It is calculated that this year 1,200,000 trees will be planted. At the present time, more than 1,600,000 pesos have been invested (annual expenses for operating these units will be about 1,500,000 starting with 1948, excluding cost of equipment and accessories). Furthermore, several million pesos will be invested this year in investigation and modernization of installations now in existence.

Digest of paper 48-184, "The Paper Industry in Mexico," recommended by the AIEE general industry applications committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21-25, 1948. Not scheduled for publication in AIEE *TRANSACTIONS*.

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Steel Industry Electrification Trends

L. A. UMANSKY
FELLOW AIEE

The steel industry has been quick to recognize the advantages of using electricity in many of its manufacturing processes. The progress made along these lines during the last 25 years indicates that this trend will continue.

THE STEEL INDUSTRY in the United States is largely electrified. It is one of the largest users of electric power. In 1947 it produced 85,000,000 tons of steel, and used approximately 200 kilowatt-hours per ton, or 17 billion kilowatt-hours.

The partnership between electricity and steel is not new. Even 25 years ago, close to 90 per cent of steel mill drives were electrified. However, the type of electric equipment used in the industry has changed radically within this period. Many manufacturing processes have been redesigned around the electric equipment in order to make full use of its advantages. Electrification permits a better utilization of waste fuel available at the steel plant. A portion of blast furnace gas is burned in the powerhouse located close to the furnaces; the power then is transmitted electrically throughout the plant and is used efficiently in numerous motor drives, of which the rolling mills are the most important.

The modern steel plants require a larger amount of power per ton of steel rolled than was the case 25 years ago. The greater proportion of flat rolled products partially explains this fact. Power produced from waste fuel does not cover the entire needs of the plant. Additional fuel must be burned or additional power must be purchased. Twenty-five years ago about two-thirds of all power needed by the steel industry was generated, and one-third purchased. Now the proportion is close to 50–50.

Many large integrated steel mills originally used 25-cycle electric equipment; some 25 years ago the proportion of 25- and 60-cycle capacity installed in the steel industry was about two to one. This trend has been reversed, and the proportion is now close to one to two, and still is going down. No new 25-cycle plants are being built. Even many existing 25-cycle plants are adding new capacity at 60 cycles. This often entails the use of frequency changers to tie the two systems together. Synchronous-synchronous frequency changers are the simplest for this purpose. However, the 25-cycle frequency seldom is maintained closely; for controlling the flow of power between the two systems it then becomes essential to use an asynchronous tie, either of the Scherbius or electronic type. Either type has been applied successfully.

Of the two voltages, 6,600 and 2,300 volts, originally used in steel mills for power generation, distribution, and utilization, the lower voltage is definitely on its way out, except for small sections of a plant's system fed from a higher voltage line through step-down transformers. Even 6,600 volts now is considered too low as a major system voltage for a large steel plant. A 3-voltage standard, 13,200–2,300–440 volts (with 11,000 volts sometimes taking place of 13,200 volt), should be considered as more suitable. For very large plants with existing 6,600-volt equipment it is possible to introduce a still higher voltage, like 24 kv, 34.5 kv, or even 69 kv for the main power distribution, stepping down to 6,600 volts in several substations.

The capacity of the rolling mill drives has more than trebled in the last 20 years. Many changes in type of drives have taken place. For heavy reversing blooming and slabbing mills the so-called twin-motor drive has been developed; the top and bottom rolls are driven by separate motors, tied together by electrical means only. The conventional "pinions" through which the rolls ordinarily are geared together are eliminated, reducing maintenance and expense. The synchronous motors, practically unknown 25 years ago, now are used in preference to induction motors when constant speed drives are needed and the use of flywheels is not called for. However, the proportion of constant speed drives is going down steadily, in favor of adjustable speed equipments.

In this latter field a rolling mill of 25 years ago, driven through line shafts and gears by one or two adjustable speed a-c drives, is giving way to a modern mill with almost as many motors as there are mill stands. Such mill gives a greater flexibility in rolling a large variety of products. D-c motors supplied with power from synchronous motor generators are selected in most cases.

Several successful drives were installed or are on order, whereby the power to the d-c mill motors is furnished by mercury arc rectifiers. These applications are limited, however, to cases when quick reversal or slowing down of the mill drives is not called for.

Some of the most notable and spectacular rolling mill applications were made in connection with the hot strip and cold strip mills. These mills had been developed in the last quarter century and are used for rolling wide flat sheets, several hundred or thousand feet in length. This continuous process greatly reduces the hand labor and, therefore, the cost of the flat rolled products, used for automobile bodies, tin plate, and a variety of other uses. A large hot strip mill rolling wide sheets at speeds up to 2,000 feet per minute may require more than 40,000 horsepower in main drives. This large concentration of

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Essential substance of paper 48-141, "Trends in Electrification of American Steel Industry," recommended by the AIEE mining and metal industry committee and approved by the AIEE technical program committee for presentation at the AIEE summer general meeting, Mexico, Federal District, Mexico, June 21–25, 1948. Scheduled for publication in AIEE *TRANSACTIONS*, volume 67, 1948.

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power requires considerable engineering study to solve the problems of smoothing the effect of peak load on the power system, ventilation of machines and motor rooms, and many others.

The cold strip mills require still more ingenuity on the part of electrical engineers. A typical mill consists of three, four, or five tandem stands with a winding reel at the delivery end. Some of the new mills for producing tin plate operate at a maximum speed in excess of 6,000 feet per minute. Each stand is driven by a separate motor. In some instances even the top and bottom rolls of a stand are driven by separate motors. All these drives are threaded at low speed, and then are accelerated quickly in step, with the strip between the stands taut and held at substantially constant tension. When one considers that this acceleration is done at a rate of some 700 feet per minute per second, or higher, the magnitude of the task so well done electrically is truly remarkable.

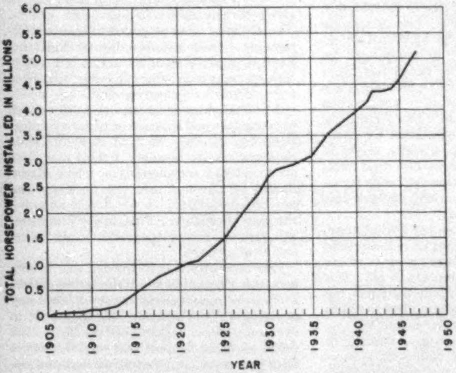

Figure 1. A cumulative curve showing total horsepower of rolling mill drives installed since 1905

From Iron and Steel Engineer, January 1948

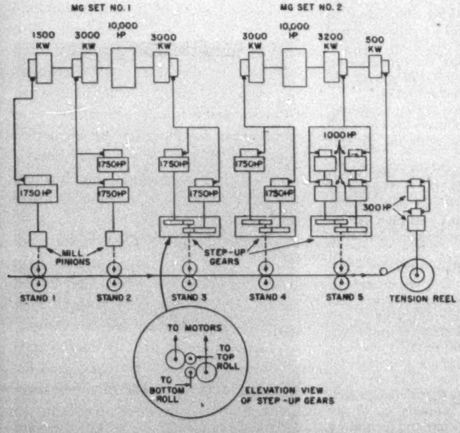

Figure 2. Layout of a tandem mill rolling cold strip at speeds up to 6,000 feet per minute

Numerous processing lines for cleaning, plating, shearing, and so forth, of the strip are growing in size, speed, and refinement of electric drives. D-c motors, with adjustable voltage control, are used almost universally. Many other steel mill auxiliary drives, such as tables, screwdowns, sideguards, at the reversing blooming mills, also are using Ward Leonard type of control. Heavy mill duty d-c motors are still the choice of the industry for this and similar service.

Electric heat is used in steel mills when quality and uniformity of products are essential. Such cases are becoming more and more numerous. The capacity of electric arc furnaces has been increased fivefold within ten years and the tonnage of alloy steels produced exceeded 5,500,000 tons in 1945. Resistor and induction furnaces are giving excellent accounts of themselves in heat treatment of alloy bars, strips, and other products. The ease and precision of control and the reduction of rejects are so outstanding that the somewhat higher cost of electric heat, on mere Btu basis, is rightly overlooked.

The partnership of electricity and steel has been quite fruitful. Electric power has contributed a large share toward economical mass production of steel on which our entire industrial life is based. If the last quarter of a century is any criterion, we should expect that in the next 25 years the art of steel making will be still closer allied to electrical engineering.

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INSTITUTE ACTIVITIES

Institute Problems

By Blake D. Hull

The Institute, I am happy to say, is doing exceedingly well considering the times. In the last five years we have increased our membership more than 40 per cent and now have 28,400 of the Associate, Member, and Fellow grades and 14,000 of the Student grade. This phenomenal growth has made it necessary to change our organizational setup. The board of directors has recognized the need for these changes and carried them out, but I feel there is still more work to be done to keep abreast of the times. I shall mention a few suggestions briefly.

It has been a pleasure to me to have served the Institute this year. I recognize much more than I did a year ago what a grand organization the Institute is, and the unselfish interest that so many of the committee chairmen and the 1,200 committee members are contributing to its success. The board of directors has been very co-operative and helpful and I am happy that the constitution provides that I shall continue as a member of the board for two years longer.

I have heard it said many times that our board is composed of too many men of the commercial or management type and not enough of the highly technical type. I cannot entirely agree with this, probably because I represent the former, but, if this is so, it comes about through our method of election. The chairmen and secretaries of the Sections are elected by the members of the Sections. They are chosen because of their activities in the Sections and as a result frequently come from the more or less nontechnical roster.

These men, as members of the District executive committee, select the vice-presidents and ten of the members of the nominating committee. I think the vice-presidents should be selected from men who are active in District and Section affairs, as their function is more of that nature, but possibly more thought should be given to the selection of directors to see that the technical activities are adequately represented on the board. After all, we are a technical society which must not be overlooked. This objective could be accomplished, if thought advisable, by adding some members from the technical committees to the nominating committee. I think this matter should be studied by a group of men who would give it unbiased consideration.

In the technical activities the plan of dividing the 31 committees into four divisions with a co-ordinator at the head of each group has worked out so well that it should be continued and unanimous support given to the creation of new committees or new groups if that should seem warranted. The men heading these committees have all done a grand job and I marvel at the work they are accomplishing.

Technical conferences under the supervision of the interested technical committees should be encouraged. Possibly the time will come when a quarterly technical publication for each technical division could be justified.

The grouping of several of the nontechnical committees into professional and administrative groups has not, in my opinion, proved as well justified as in the case of the technical work, simply, as I see it, because similar work is not being done by all of these committees and there is not as much need for close co-ordination. The board has taken recognition of this fact for the administrative group and has abandoned it. I am sure this was wise, but am not so sure that a grouping for closer co-operation would not be advisable for the membership, transfer, board of examiners, and Member-for-Life fund committees. They all are concerned with somewhat similar interests, namely, the membership and its classification.

In the professional grouping I think some similar action might be justified. Here again similar work is being done by some of the committees in the group but not by all. It is my suggestion that this whole matter of the nontechnical committees be studied to determine what the proper action should be.

We have Districts varying in number of Sections from one to 16, and with Subsections, Student Branches, and members varying to an even larger per cent. This is unfair to both the large and the small Districts. An attempt was made some time ago to see what adjustments could be made but this effort was dropped because of opposition.

I appreciate that a readjustment of Districts is not going to be an easy thing to do, but I believe it is something that should be given careful thought, and a redistribution of territory made to more equitably equalize the work in each. I see no fundamental reason why country boundaries should not be disregarded in this redistribution.

With a year's experience as your president, I am impressed with the heavy load of work thrown on the president with the present organization.

I am heartily in support of the plan inaugurated a few years ago by the board to throw more responsibility and work on the vice-presidents and I think this plan should be re-emphasized and encouraged, but even that is not enough.

In my judgment, the time is coming when we should have an executive vice-president, or whatever you may wish to call him. He should be a man with wide authority to run the Institute under the direction of the board. The board, in my opinion, today is devoting too much of its time to details and national committee chairmen are also doing too much detail work. I appreciate that a change such as I suggest means the building up of the general office force somewhat and increasing the expense considerably and that this may not be the time to do it, but I think relief along this line is necessary in the near future. Some immediate relief could be obtained by giving the secretary more authority, or by appointing an assistant to the president from the board to assume certain responsibilities. I favor the former. It is interesting to note that some 18 to 20 years ago we gave the national secretary the additional title and job of executive manager and he had an assistant secretary.

Subsections have worked out exceedingly well. They should be encouraged where there is a sufficient number of members, or prospective members to form such groups. These should be encouraged to become Sections as soon as possible, but on the other hand, I think Sections should be reduced to Subsection status where interest has been reduced below a certain standard.

I find considerable confusion in the minds of counselors and students as to joint Student Branches. I am somewhat doubtful as to their real merit; however, I think that if we are to sanction such action, the whole matter should be clarified and the purposes and procedure outlined; or we should abandon the plan altogether. This, in my judgment, will require the co-operation of the other technical societies.

Our constitution is so worded that it subjects us to the critical eye of the taxing agents. I think this matter should be faced fairly and squarely and the necessary changes made in our constitution and bylaws to clarify that point. During the past year several changes have been made in our constitution and bylaws and others are needed. I am glad to say this work is going forward, but slowly, as it should for safety.

Blake D. Hull

Committee appointments in Section, District, and national affairs should be given careful attention. They should be made on the basis of individual qualifications and not because it becomes a member's turn or because he represents a certain interest. Proper qualifications for the job at hand should always be the first consideration. We have more than 1,200 serving on the various committees. Some are not active, but most are. Inactive committeemen should be dropped and new members, who are interested, added. On these men depends the success of the Institute. They are giving of their time and are not receiving any financial aid from the Institute. They are largely representatives of our large industrial plants and companies and from our colleges, and I think these institutions merit the deep appreciation of the Institute for their contributions to this cause.

The American Institute of Electrical Engineers should co-operate with all other engineering societies when there are matters of mutual interest. It should not, however, relinquish any part of the electrical field because some other society becomes active in it.

In closing I want to mention what I consider the most important need of the engineering profession in the United States today. I have stressed it in my visits around the country and I reiterate it again today. It is imperative that we have an association composed of qualified engineers that can speak for all engineers on subjects common to all, including those of a nontechnical nature. I think we are nearer to an agreement on this subject than we were a year ago, but there are still too many in responsible positions satisfied with the present situation and not desirous of getting a representative body together to talk the matter over. I am glad to say the electrical engineers are ready to meet and our board has given magnificent support in this matter. I hope the discussions on this important subject will not stop.

It has been a great experience for me this last year. I have met many very fine people in my journeys over the country, and I hope have made as many friends as I have met people. All of the courtesies shown Mrs. Hull and myself on our trips have been very much appreciated and will long be remembered. It is with pleasure that I turn the gavel over to a man of Everett Lee's ability and interest in Institute affairs to carry on. I prophesy for the Institute increased activity and larger accomplishments for the coming year.

Our Institute

By Everett S. Lee

We are advancing into our 65th year; the years of the electrical era.

We are 29,000 strong—Associates, Members, Fellows, Honorary.

We have 14,000 Student members studying in the engineering schools to be graduated in electrical engineering.

Everett S. Lee

We are the electrical engineering profession.

We glory in fulfilling the dreams of our Founders.

We have advanced electricity into every available avenue for the service of man, which has been characterized as more revolutionary for the well-being of the people of the world than any other material thing in recorded history.

A flip of the switch and there is light, heat, power,—the contributions of the engineers of the great electric light and power industry have brought the service of electricity to every home, to every factory, to every ministry, to every distribution.

A ring of the bell and there is a voice, near or far; a turn of the dial and there is the world—the contributions of the engineers of the great communications industry have brought man to man, dear one to dear one, scene and story to all.

A turn of the throttle and the world moves,—the contributions of the engineers of the great transportation industry speed mankind on his way and move the produce of trade.

A touch of the control button and the wheels of industry turn,—the contributions of the engineers of the great industries of our land bring to man everything that is produced.

From the contributions of the engineers of the great electrical manufacturing industry come the entire complement of machinery for electricity production and safe distribution, the motors for power, the lamps for light, the appliances for every home service, and the sets for home entertainment.

From the contributions of the consulting engineers and from the engineers of the great electrical contracting industry, comes the establishment of firm principles and substantial structures that the whole will be effectively housed.

From the contributions of the engineers in government comes the best of engineering endeavor and thought for those services of river control and harbor development and other services reserved to our government.

From the contributions of the engineers who teach in our engineering schools comes the engineering graduate, with enthusiasm ready to add his services to those of his associates.

And throughout all these contributions is the electrical engineer—and the service he has written is the story of our Institute as it is preserved in our *TRANSACTIONS.*

We honor those who have preceded us for building as they have built. We apply ourselves to the continual advancement of the theory and practice of electrical engineering and the allied arts and sciences.

The engineering contributions we make for the service of mankind determine our professional standing. We will assemble ourselves together during the coming year in general meetings, District meetings, Section meetings, and Student Branch meetings, where each member may describe to his associates the work he has done to the advancement of the theory and practice of electrical engineering and the allied arts and sciences, and when he tells it to his associates, he tells it to the world. And as these contributions are of the highest service, so is our professional standing of the highest.

This is our Institute at work—that new engineering contributions may be described by the individual engineer and that as these are added to what has been standardized before, the whole may be appropriately advanced. Here our large technical committee organization operates to progress the technical aspects of the engineering work, these committees including the many phases of electrical engineering that the coverage will be complete.

To the educational and scientific work of our Institute is added for each member the enthusiasm and the inspiration from freely meeting together with his associates, associates who have studied to have knowledge beyond the special, skill beyond the skillful, judgment as to action, wisdom as to compromise, responsibility for human safety, and appreciation and contribution of service to mankind specifically in engineering contribution, and broadly in the leadership and in the guidance and direction of others to make available the benefits of the products of nature and of the forces of nature for man's continuing use. These are the attributes of the engineering profession; these are the attributes of the electrical engineer. And the professional committees of our Institute progress these. And as the electrical engineer as a citizen lives with his fellow men, these attributes motivate him in civic duty and service.

To our brother engineering societies, we give recognition for their contributions to us; it is our privilege to serve with them also.

Thus does our Institute enter another year. May each member recognize the opportunity he has for service in our Institute and progress it, that the year will advance the contributions of the past and provide an effective augmentation. Each member benefits from the efforts of all, in proportion to what he, himself, gives.

Technical Program With Western Accent Announced for Pacific General Meeting

Final arrangements have been completed for the AIEE Pacific general meeting which will be held in Spokane, Wash., August 24–27, 1948, with headquarters in the Davenport Hotel. A broad technical program of special interest to western engineers co-ordinated with inspection trips, entertainment, and social activities, as well as a special program for the visiting women has been arranged. Spokane and its environs provide an ideal opportunity to attend the meeting in combination with a few days vacation. The city is surrounded by a region of clear mountain lakes and within a day's easy motoring of seven national parks.

ENTERTAINMENT

The president's reception and dance will be held on Tuesday, August 24. Entertainment will be provided and the party will be without charge for all those who are registered.

Wednesday noon there will be a joint luncheon with the Associated Engineers of Spokane and AIEE President Everett S. Lee will address the gathering.

On Thursday evening the banquet will be held, which will be strictly informal, and after dinner entertainment will be provided under the direction of Byron Swanson, master of ceremonies. Thursday noon, the service clubs in Spokane, including Kiwanis, Rotary, Lions, Exchange, Active, and others hold their regular weekly meeting and all of the clubs at that time will welcome their visiting members from other parts of the United States. Thursday afternoon has been set aside for the inspection trips or a golf tournament.

WOMENS' ENTERTAINMENT

A number of events are planned especially for the women registered at the meeting, including a bridge luncheon at Clark House on beautiful Hayden Lake about 40 miles from Spokane. Transportation will be provided for the women from Spokane to the Clark House and return, and the guests will have the opportunity of seeing the Spokane Valley, Coeur d'Alene Lake, and mountains, returning in the evening in time for the evening's entertainment.

STUDENT ACTIVITIES

Nearly all of the colleges and universities in Districts 8 and 9 expect to have staff members and Student Members at the sessions. Two Student sessions will be held and the titles of papers will be in the final program.

SIGHTSEEING AND MISCELLANEOUS

Special inspection trips have been arranged for the men (women are also welcome to attend) which will include trips through various power plants and industrial plants.

Registered visitors will be assisted in planning other trips to suit their tastes, such as tours through the national parks, various lakes, theatres, and museums. The Pacific Northwest is still relatively young country by comparison with other parts of the United States and there are many historical points which are of interest to visitors, including parts of the Lewis and Clark wagon trails from the early days, Captain John Mullen military roads, and old forts which were established more than 100 years ago. Many of these places still provide an interesting trip for the visitor.

GOLF TOURNAMENT

The golf tournament will be held Thursday afternoon, August 26, at the Spokane Country Club. The perpetual trophy, the John B. Fisken cup (donor—John B. Fisken, of Spokane, Wash.) will be awarded to the best 18-hole medal round score and there also will be prizes for the players. Transportation can be arranged.

INSPECTION TRIPS

The following inspection trips have been scheduled for the meeting:

Bunker Hill and Sullivan Mining and Concentrating Company at Kellogg, Idaho, 13,000-volt underground distribution system.

Bonneville Power Administration—500,000-kva substation at Mead, Wash.

Permanente Metals Company aluminum reduction plant at Mead, Wash.

The Trentwood aluminum rolling mill of Permanente Metals Company at Trentwood, Wash.

Grand Coulee Dam at Coulee Dam, Wash.

In addition to the afore-mentioned trips, others can be arranged to meet the desire of members and guests such as visits to lumber mills, mines, pole manufacturing plants, light metal foundries, logging operations.

HOTELS

Those who will attend the meeting should make reservations by writing directly to the hotel and registration committee. Although arrangements have been made for sufficient rooms for the number expected to attend, they will be held until meeting time only, unless especially reserved by those who expect to occupy them.

Meeting headquarters will be in the Davenport Hotel. Rates for single bedrooms vary from $5 to $8, double bedrooms from $8 to $12, and twin bedrooms from $8 up. Other hotels in the vicinity are the Spokane Hotel, Culmstock Arms, and Desert Hotel.

ADVANCE REGISTRATION

Those who have received an advance registration card should register in advance by filling in and mailing the card promptly. Others who have not received an announcement by mail and the advance registration card should register by writing to N. H. Meyers, Chairman, Hotel and Registration Committee, General Electric Company, 162 South Post Street, Spokane 8, Wash., stating reservations desired for hotel rooms with the date and time of arrival and departure. This greatly will assist the committees making arrangements. A registration fee of $2 will be charged all nonmembers, except Enrolled Students and the immediate families of members.

COMMITTEES

The Pacific general meeting committee for 1948 is as follows:

Richard McKay, *chairman;* H. C. Glaze, Jr., *vice-chairman;* H. Jack Reeves, *secretary;* T. Wendell MacLean, *treasurer;* W. H. Blankmeyer; J. L. Buckley; D. I. Cone; M. D. Dufly; H. M. Gustafson; D. R Hoopes; G. E. Jenner; C. A. Poppino; W. C. Smith; H. D. Strong; C. F. Terrell

Subcommittee chairmen are

H. B. Hodgins, *program;* N. H. Meyers, *hotel and registration;* Glen George, *transportation and trips;* H. L. Vincent, entertainment; W. L. Thrailkill, *golf;* R. D. Sloan, *student activities;* Hugh B. Tinling, *publicity;* W. W. Watkins, *finance;* Mrs. L. R. Gamble, *ladies' entertainment*

Sunset Highway entering Spokane from the west

Tentative Program

Pacific General Meeting, Spokane, Wash., August 24–27, 1948

Tuesday, August 24

8:30 a.m. Registration

10:00 a.m. Opening of Meeting

Welcome: Arthur R. Meehan, mayor of Spokane
Response: Walter C. Smith, director, AIEE

10:15 a.m. General Session

Introduction of Everett S. Lee, president, AIEE

Address: "My Policies for the AIEE, 1948–49," Everett S. Lee

Address: "Long Range Planning for Power Supply," Fred O. McMillan, director, AIEE

12:00 m. Spokane Chamber of Commerce Membership Meeting

Talk by Everett S. Lee

2:00 p.m. Power Generation and Hydraulics

CP.* Progress Report on the Northwest Power Pool. *L. B. Cowgill, E. N. Peterson,* Portland (Northwest Power Pool)

48-191. Modern Trends in Hydraulic Turbine Design. W. J. Rheingans, Allis-Chalmers Manufacturing Company

CP.* Generator Erection at Coulee Dam. *A. F. Darland,* Coulee Dam (United States Bureau of Reclamation), *J. L. Berry,* Coulee Dam (W)

48-192. Irrigation Pumping With Grand Coulee Power. *S. M. Denton,* Bureau of Reclamation

48-200. Pumping for Power in the Colorado Rockies. *F. M. Wilson,* Bureau of Reclamation

2:00 p.m. Conference on Nucleonic Instruments

CP.* Health, Physics, and Related Instruments. *H. M. Parker,* Hanford Engineering Works

CP*. Survey of Nucleonics Instrumentation. *N. A. Marshall,* Navy Radiological Defense Laboratory, San Francisco

CP.* High-Voltage Accelerators

CP.* Power Aspects of Nucleonics

8:30 p.m. President's Reception and Dance

Wednesday, August 25

9:30 a.m. Transmission and Distribution

48-193. Development of the 230-Kv Ring Bus for Grand Coulee Power Plant. *N. G. Holmdahl, C. L. Killgore,* Bureau of Reclamation

48-202. Joints and Clamps for Aluminum Conductors. *G. B. Tebo,* The Hydro-Electric Power Commission of Ontario

48-195. Economics of Long Distance Energy Transmission. *R. E. Pierce, E. E. George,* Ebasco Services, Inc.

48-196. Development of the 230-Kv Transmission System and Switchyard Connections for Grand Coulee Power Plant. *B. V. Hoard, E. E. Helwith,* Bonneville Power Administration

9:30 a.m. Electronics

48-197. Measurement of Interference of Radio-Frequency Heating Equipment. *G. H. Brown,* RCA Laboratories. Presentation by title

—PAMPHLET reproductions of author's manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

—PRICES for papers, irrespective of length, are 30 cents to members (60 cents to nonmembers) whether ordered by mail or purchased at the meeting. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

—COUPON books in five-dollar denominations are available for those who may wish this convenient form of remittance.

—THE PAPERS regularly approved by the technical program committee ultimately will be published in PROCEEDINGS and TRANSACTIONS; also, each is scheduled to be published in ELECTRICAL ENGINEERING in digest or other form.

CP.* Analysis of Nonlinear Control Systems. *G. D. McCann, G. H. Wilts,* California Institute of Technology

48-189. Radio for Telephone Service in America. *H. I. Romnes,* American Telephone and Telegraph Company

CP.* Radio for Telephone Service on the Pacific Coast. *A. P. Hill,* Pacific Telephone and Telegraph

48-198. The Measurement and Investigation of Ionization Level of Rubber-Insulated Cable. *R. C. Graham,* Rome Cable Corporation; *E. K. Duffy, W. R. Foster,* Thermionic Engineering Corporation

12:00 m. Joint Lunch Meeting with Associated Engineers of Spokane

A. E. Weissenborn, president, Associated Engineers of Spokane, *chairman*

CP.* Applications of Induction and Dielectric Heating in Industry. *R. A. Neilsen,* Westinghouse Electric Corporation

2:00 p.m. Transmission and Distribution

48-199. Results of Tests Carried Out at the 500-Kv Experimental Station of Chevilly, France, Especially on Corona Behavior of Bundle Conductors. *François Cahen,* Electricite de France. Presentation by *Charles F. Wagner*

48-201. The Space Charge Due to Corona. *Otto J. M. Smith,* University of California

48-204. A Universal Telemetering System. *L. Dale Harris,* University of Utah

2:00 p.m. General Industry Applications

48-205. Electrification of an Ore Haulage System. *R. J. Corfield,* Kennecott Copper Corporation

48-206-ACO. A 13.2-Kv Distribution System in a Mine.** *L. M. Griffith,* Bunker Hill and Sullivan Mining and Concentrating Company

48-190. The Bellingham Hydraulic Log Barker. *V. C. Haner,* Puget Sound Pulp and Paper Company; *H. A. Rose,* Westinghouse Electric Corporation

CP.* Sectional Paper Machine Drives with Multiple Generators. *F. S. Parker,* General Electric Company

7:30 p.m. Student Session

Thursday, August 26

9:30 a.m. Transmission and Distribution

48-210. Magnetic Suspension of the Watt-Hour Meter Rotor. *H. E. Trekell, L. I. Mendelsohn, J. H. Wright,* General Electric Company

48-207. The Linascope—An Echo-Ranging-Type Fault Locator for High-Voltage Lines. *J. R. Leslie, K. N. Kidd,* The Hydro-Electric Power Commission of Ontario

48-208. A Transmission Line Fault Locator Using Fault-Generated Surges. *R. F. Stevens, T. W. Stringfield,* Bonneville Power Administration

CP.* The High-Voltage Distribution System in Spokane. *E. G. Peters, Earl Baughn,* Washington Water Power Company

48-209–ACO. System Expansion Utilizes 69-Kv Package Substations.** *J. F. Sinnott,* San Diego Gas and Electric Company; *L. D. Madsen,* General Electric Company

9:30 a.m. Student Session

12:00 m. Student Lunch

12:00 m. Service Club Luncheon Meetings for Club Members

AIEE speaker for Rotary Club lunch

AIEE speaker for Kiwanis Club lunch

1:30 p.m. Golf at Spokane Country Club

1:30 p.m. Inspection Trip to Mead Aluminum Reduction Plant of the Permanente Metals Corporation, and Spokane Substation of Bonneville Power Administration

1:30 p.m. Inspection Trip to the Trentwood Aluminum Rolling Mill of The Permanente Metals Corporation

6:30 p.m. Banquet and Entertainment; Presentation of Golf Prizes

Friday, August 27

8:30 a.m. Inspection Trip to Grand Coulee Dam, Power Plant, and Switchyard

8:30 a.m. Inspection Trip to Surface Plant and Mine of Bunker Hill and Sullivan Mining and Concentrating Company, Kellogg, Idaho

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***CP.** Conference paper; no advance copies are available; not intended for publication in *TRANSACTIONS.*

**** ACO.** Advance copies only available; not intended for publication in *TRANSACTIONS.*

Washington Section to Be Host to Middle Eastern District

The forthcoming Middle Eastern District meeting will be held in Washington, D. C., October 5–7, 1948, with headquarters in one of the capital's newest and finest hotels, The Statler. A technical program presenting a well balanced variety of subjects is being planned. Inspection trips coordinated with some of the papers as well as those of general interest are being scheduled. There will be ample opportunity to see the famous Washington buildings and monuments.

The technical program will include a joint session with the Institute of Radio Engineers–U.R.S.I. (International Scientific Radio Union). Papers on television, military meteorological communication, air transport radar, and the New York–Boston telephone relay system have been scheduled.

Another joint session with the Illuminating Engineering Society will cover such subjects as atmospheric transmissometry, modulated light, sources for projection equipment, physical detectors, and lamp developments. A total of 20 papers on air transportation, 8 on naval test, 20 on marine transportation, 4 on rural electrification, 8 on power, 4 on nuclear engineering, 4 on electric instruments and engineering developments, 4 on communications, and a forum on engineering education have been planned.

An inspection trip to the Bureau of Standards offers an excellent opportunity to see one of the most modern high-voltage laboratories in the United States, as well as numerous pieces of intricate testing equipment. The two-thirds of a mile long testing channel with its complex towing equipment will be seen at the David Taylor Model Basin. A cyclotron and electrostatic generator are available at the Carnegie Institution laboratory for atomic research. The *Constitution*, which is the United States Navy's largest land-based airplane, will be available at National Airport for inspection during the meeting.

Midwest General Meeting to Feature Broad Program

Arrangements tentatively made for the Midwest general meeting to be held in Milwaukee, Wis., October 18–22, 1948, indicate that a technical program of broad interest is in prospect. Approximately 36 technical sessions and conferences are being developed in three broad fields; communication and science, power, and industry. Headquarters for the meeting will be in the Schroeder Hotel.

In the field of communication and science, sessions will embrace papers on home receivers, broadcast transmitters and systems, switching systems (telephone and telegraph), railroad communications, radio aids to navigation, and basic sciences. In the field of power, there will be sessions on power generation, transmission and distribution, transformers, carrier current, relays, cables, switchgear, and system engineering. In the industrial field, sessions on machine tools, material handling, steel, mining, interior wiring, electric furnaces, dielectric and induction heating, and industrial control are being arranged. Plans also are being made for a joint session by the committee on education in co-operation with the committee on Student Branches.

In addition, the Midwest general meeting committee is actively engaged in making arrangements for inspection trips to be coordinated with the program as well as social events and entertainment. Nothing will be left undone, so that a busy and profitable week will be enjoyed by all who attend.

Tentative Program Outlined for Third AIEE Conference

Doctor J. J. Smith (General Electric Company, Schenectady, N. Y.) cochairman of the AIEE-Institute of Radio Engineers conference on electronic instrumentation in nucleonics and medicine which is to be held in the Engineering Societies Building in New York, N. Y., November 29–December 1, 1948, has announced that a tentative draft of the program has been drawn up by the program committee. Doctor G. W. Dunlap of the general engineering and consulting laboratory of General Electric Company is chairman of the program committee.

November 29, 1948

1. Biological Requirements in Amplifiers
2. Present Practice in Biological Amplifier Design
3. Biological Requirements in Recording Devices
   (*a*). Cathode-Ray Photography
   (*b*). Electrocardiograph
   (*c*). Electroencephalograph
   (*d*). Other Types
4. Present Practice in Biological Recorder Design

November 30, 1948

1. Biological Requirements for Radioactive Isotope Measurements
2. Discussion of Foregoing Paper
3. Stable Isotope Measurement (Possibility of Use Quality of Instrumentation Techniques)
4. Thin Window Beta Counters
5. Electron Multiplier Counters
6. Crystal Counters
7. Health Protection Instrumentation (Including Survey Instruments)
8. Health Protection Techniques

December 1, 1948

1. Geiger Counters
2. Proportional Counters, Including Alpha and Neutron (BF$_3$ and Boron-Coated)
3. Ionization Chambers

AIEE PROCEEDINGS

Order forms for current AIEE *PROCEEDINGS* have been published in *ELECTRICAL ENGINEERING* as listed below. Each section of AIEE *PROCEEDINGS* contains the full, formal text of a technical program paper, including discussion, if any, as it will appear in the annual volume of AIEE *TRANSACTIONS.*

AIEE *PROCEEDINGS* are an interim membership service, issued in accordance with the revised publication policy that became effective January, 1947 (*EE, Dec '46, pp 576–8; Jan '47, pp 82–3*). They are available to AIEE Student Members, Associates, Members, and Fellows only.

All technical papers issued as AIEE *PROCEEDINGS* will appear in *ELECTRICAL ENGINEERING* in abbreviated form.

Location of Order Forms	Meetings Covered
Apr '48, p 49A	Winter general
Aug '48, p 45A	Great Lakes District North Eastern District Summer general

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View of mall from the United States Capitol showing Federal Triangle—Washington, D. C., host to the Middle Eastern District meeting, October 5–7, 1948

(*a*). Ionization Chamber Measurements (Including D-C Amplifiers and Electrometers)
4. Stabilized High-Voltage Supply for Counters and Chambers
5. Cloud Chambers
6. Photographic Emulsion
7. High-Speed Counting Techniques (Including Pulse Amplifiers)
8. Autoradiography

Authors of papers and program changes will be announced in *ELECTRICAL ENGINEERING* as they are decided upon.

An important feature of the conference will be a display of nucleonic instruments by the Atomic Energy Commission. The display will be set up in the Engineering Societies Building convenient to the meeting auditorium.

Those interested in being placed on the special mailing list for receiving advance programs and registration material for the conference, or knowing of other individuals or organizations who are interested, should write C. C. Wilson at AIEE headquarters, 33 West 39th Street, New York 18, N. Y.

Pennsylvania Hotel Designated Winter Meeting Headquarters

As the 1949 AIEE winter general meeting will be held this year during the week of January 31 through February 4, 1949, under somewhat different conditions than have applied in previous New York general meetings in that the meeting headquarters will be in the Pennsylvania Hotel, it is believed that an early announcement of the principal activities will be of value to the membership.

The technical program probably will consist of 50 to 55 technical sessions and conferences, but this program will not be completed until some time in the Fall. An interesting series of inspection trips is being planned as closely correlated with the technical sessions as possible. Plans also are now underway for both a smoker and a dinner-dance. Particular attention is called to the fact that it has been necessary to reverse the nights on which these affairs have been staged in the past—the dinner-dance will be given at the Pennsylvania Hotel on Tuesday night, February 3, 1949, and the smoker at the Commodore Hotel on Thursday night, February 4, 1949. The prices of the tickets have not been settled as yet. An extensive program of entertainment for the women attending the meeting is under development. For the accommodation particularly of the members from out-of-town, blocks of theater tickets for popular shows will be available for sale in advance of the meeting.

To defray the expenses incurred by the Institute in the holding of meetings, the board of directors has ruled that future meetings must be placed on a substantially self-supporting basis. In view of this action, registration fees will be in force for both members and nonmembers. These fees will be announced at a later date.

As it is believed most of those who attend the meeting will want to be located in the headquarters hotel, the Pennsylvania has agreed to set aside a large number of rooms for Institute use. Registration forms for room reservations will be prepared and the membership is urged to take advantage of this opportunity and to enter reservations as soon as possible after the necessary forms become available.

As it becomes available, further and more definite information on what promises to be one of the largest AIEE meetings ever held will appear in *ELECTRICAL ENGINEERING.* The greater facilities available at the hotel over those at the Engineering Societies Building will insure a more effective meeting from every viewpoint.

Organization Completed for Electric Welding Conference

E. H. Vedder, chairman of the AIEE electric welding committee has announced that the appointment of the various working groups has been made and plans rapidly are being formulated for this conference to be held December 6, 7, and 8, 1948 in the Engineering Society Auditorium in Detroit, Mich.

The conference chairman is Mr. Vedder, who is with the Westinghouse Electric Corporation, Buffalo, N. Y.

Other officers and committees for the conference will be the following.

Executive Committee: B. L. Wise, C. E. Smith, M. Zucker, H. I. Stanback, G. W. Garman, C. N. Clark

Program Committee: G. W. Garman (*chairman*); C. M. Rhoades, Jr., C. E. Smith, R. C. McMaster, R. C. Freeman, G. M. Chute, E. F. Steinert, A. M. Unger, F. J. Wells

Publicity Committee: H. I. Stanback (*chairman*), H. W. Snyder, L. K. Stringham, H. Watson Tietze, R. E. Young, E. M. Callender, J. F. Deflenbaugh, J. Harold Lampe, A. G. Turnbull

Publication Committee: C. N. Clark (*chairman*), G. I. F. Theriault, S. Shiozawa, W. E. Crawford, W. B. Kouwenhoven, J. C. Learman, F. Rothganger, J. R. Sellenberg, E. W. Davis

A meeting of the executive committee is scheduled for July 14 in Cleveland, Ohio, where progress by the various committees will be reported and a general theme for the conference decided upon.

Persons desiring to be included on a special mailing list to receive announcements, programs, and registration material for the conference, or knowing of any individuals or organizations so interested, should communicate with H. I. Stanback, Chairman, Publicity Committee, AIEE Conference on Electric Welding, Square D Company, 4041 North Richards Street, Milwaukee, Wis.

President Hull Visits Home Section in St. Louis

On May 19 President Hull met with the executive committee of the St. Louis Section and the Student Branch committees of the University of Missouri at Columbia, Missouri School of Mines and Metallurgy at Rolla, and Washington University at St. Louis, at a noon luncheon in the De Sota Hotel. Mr. Hull heard reports of the several committee chairmen and then recounted a number of his experiences since becoming president. He explained the Institute's plan for rewarding winners in student competitions, and expressed surprise at the number of Sections not familiar with the plan.

In the evening, the annual triple-feature meeting was held. This was preceded by a cafeteria-style dinner in Lee Hall at Washington University for the electrical engineering students and faculties of the three co-operating schools, and members of the St. Louis Section.

After dinner, the meeting was called to order in Brown Hall Auditorium on the campus. Section officers for 1948–49 were introduced. Following this, past chairmen, who, as in previous years, had received

Future AIEE Meetings

Pacific General Meeting
Spokane, Wash.
August 24–27, 1948
(*Final date for submitting papers—closed*)

Middle Eastern District Meeting
Hotel Statler, Washington, D. C.
October 5–7, 1948
(*Final date for submitting papers—closed*)

Midwest General Meeting
Schroeder Hotel, Milwaukee, Wis.
October 18–22, 1948
(*Final date for submitting papers—August 3*)

Southern District Meeting
Birmingham, Ala.
November 3–5, 1948
(*Final date for submitting papers—August 20*)

AIEE/IRE Conference on Electronic Instrumentation in Medicine and Nucleonics
Engineering Societies Building
New York, N. Y.
November 29–December 1, 1948

AIEE Conference on the Textile Industry
Atlanta, Ga.
Fall, 1948

AIEE Conference on Electric Welding
Engineering Society of Detroit Building
Detroit, Mich.
December 6–8, 1948

AIEE Conference on High-Frequency Measurements
National Bureah of Standards, Washington, D. C.
January, 1949

Winter General Meeting
Pennsylvania Hotel, New York, N. Y.
January 31–February 4, 1949
(*Final date for submitting papers—November 16*)

AIEE Conference on the Textile Industry
Boston, Mass.
Spring, 1949

AIEE Conference on Electron Tubes
March, 1949

AIEE Conference on the Rubber and Plastics Industry
Akron, Ohio
March, 1949

South West District Meeting
Dallas, Tex.
April 19–21, 1949

Summer General Meeting
New Ocean House, Swampscott, Mass.
June 20–24, 1949

Pacific General Meeting
Fairmont Hotel, San Francisco, Calif.
August 23–26, 1949

AIEE Conference on Industrial Power Distribution
Date to be announced

special invitations to this annual get-together, were introduced. President Hull, himself a past chairman of the Section, then gave an informative talk on the subject, "Institute Activities."

Following President Hull's address, several papers were presented in competition for the St. Louis Section trophy and three cash prizes which subsequently were awarded as follows:

First prize: "A Direct-Coupled Amplifier Stage Which Minimizes Cathode Drift Effects," Robert C. Hansen, Missouri School of Mines and Metallurgy

Second prize: "A Vacuum Tube Relay Oscillator," Carl Van Hooser, University of Missouri

Third prize: "Frequency Response and Distortion in the Webster Wire Recorder," James J. Skiles, Washington University

Prize Paper Awards Presented at District 3 Student Meeting

The District 3 (New York City) Student Branch meeting was held in New York on May 7, 1948. Morning and afternoon sessions were devoted to inspection trips of the American Telephone and Telegraph Company's long lines department and the Consolidated Edison Company's Waterside generating plant.

At noon the long lines department served an excellent lunch, which was followed by an address of welcome from L. G. Woodford, manager of the long lines department. Doctor O. E. Buckley, vice-president of District 3, presented the prize paper awards, and M. E. Strieby, staff executive of the long lines department, gave a brief talk highlighting the activities of the long lines department. This latter talk was concluded with a brief microwave demonstration.

Five prize paper awards were presented. They are

First prize to John B. Walsh, Manhattan College, for his paper "An Analysis of Nonlinear Functions"

Second prize to Irving Weintraub, Columbia University, for his paper "A-C Auxiliary Power Systems for Aircraft and a New Variable-Speed Constant-Frequency Generator"

Third prize to Harold E. Stinehelfer, Polytechnic Institute of Brooklyn, for his paper "Obtaining the Characteristics of Tuned Transformers and Discriminators Directly on an Oscilloscope"

Honorable mention to Morten Gale, New York University, for his paper "Electrical Recreations"

Honorable mention to William E. Warden, Pratt Institute, for his paper "Radio Control for Model Railroads"

AIEE Dayton Section Holds Annual Meeting

On the occasion of the annual meeting of the AIEE Dayton Section on Wednesday, May 19, 1948, approximately 100 members and students from Dayton, Ohio, and the surrounding territory were guests of the Hobart Brothers Company at their plants and at Treasure Island Park, in Troy, Ohio. The meeting opened at 3 p.m. with a conducted tour of the shops and buildings of the welded products, welding school, and welding rod divisions, and of Motor-Generator Corporation, a subsidiary of Hobart Brothers Company.

Following the tour, the visitors were driven out to Treasure Island Park, recreation center, where they saw the boathouse and dance pavilion, an imposing array of boats, and the recently completed island picnic ground. They also were treated to a display and demonstration of several types of Hobart Brothers mobile welding equipment and a demonstration of hard-facing welding.

Concluding the meeting was a dinner at the Hobart Brothers Canteen, served by Welfare, Inc., the Hobart Brothers employees' association, followed by the business meeting. Speakers at the dinner were: E. A. Hobart, president, and O. H. Menke, plant superintendent, of Hobart Brothers Company. W. A. Barden, chairman of the Dayton Section, presided at the business meeting, at which the results of the election of Section officers for the year 1948–49 were

Attending the executive committee meeting in St. Louis, Mo., are the following St. Louis Section and Student Branch officers. Standing, left to right: H. B. Seybt, past chairman; R. C. Horn, vice-chairman-elect; W. D. Becker, alternate, University of Missouri; J. C. Lebens, chairman, Student activity committee; J. R. Somerville, chairman, Student Branch, University of Missouri; Professor I. H. Lovett, counselor, Student Branch, Missouri School of Mines and Metallurgy, Rolla, Mo.; W. B. Murney, chairman, Student Branch, Missouri School of Mines and Metallurgy; C. W. Schemm, chairman, membership committee; R. E. Sontag, chairman, entertainment committee. Seated at table: R. N. Slinger, secretary-treasurer; President B. D. Hull; E. S. Rehagen, chairman; R. W. Gaskins, vice-chairman, chairman-elect. Foreground, left to right: E. E. Gilcrease, chairman, publicity committee, secretary-treasurer-elect; W. D. Helm, chairman, fellowship committee; W. F. Brandenburger, chairman-elect, Student Branch, Washington University, St. Louis; Professor P. M. Honnell, counselor, Student Branch, Washington University

E. A. Hobart addressing the Dayton Section meeting (May 19, 1948). Seated facing the camera, left to right, are O. H. Menke, J. O. Lang, L. H. Fox, and W. A. Barden

(Left to right) H. E. Rue, chairman of the Canton Section; George L. Draflan, president of the Ohio Brass Company; and H. N. Van Aken, an officer of the Akron Section, comparing the 25,000,000th suspension insulator (left) made at the Barberton plant of the Ohio Brass Company with the original unit (right) produced in 1911. The occasion was an inspection trip through the insulator manufacturing plant by the AIEE Canton and Akron Sections

announced. Following the official business, J. H. Blankenbuehler presented a description of the design problems encountered in welding equipment and welding rods, and Glynn Williams described the special motor-generator sets manufactured by the Hobart Brothers Company.

The newly elected officers of the Dayton Section, are as follows:

W. R. Appleman, The Master Electric Company, *chairman;* C. G. Veinott, Westinghouse Electric Corporation, Lima, Ohio, *vice-chairman;* C. H. Spitler, Leland Electric Company, *secretary-treasurer;* W. J. McLain, Dayton Power and Light Company, *assistant secretary;* L. D. Clark, The Master Electric Company, D. R. Freidline, Dayton Power and Light Company, R. S. Hull, National Cash Register Company, W. H. McCandless, Air Materiel Command, J. H. Blankenbuehler, Hobart Brothers Company, Troy, and O. G. Coflman, Robbins and Myers, Inc., Springfield, *directors.*

Chairmen of the discussion groups will be

electrical-engineering-in-aeronautics discussion group, R. L. Dingle, Air Materiel Command; *electric motors and controls discussion group,* I. M. Levy, Delco Products division of General Motors Corporation; *industrial electronics discussion group,* R. F. Zimmerman, Frigidaire division of General Motors Corporation.

The program was under the direction of J. O. Lang, program chairman of the Dayton Section and O. H. Menke.

Brass Company Visited by Canton and Akron Sections

An inspection trip through the Ohio Brass Company at Barberton, Ohio, was enjoyed by 55 members of the AIEE Canton and Akron Sections on May 12, 1948. The group convened at 8:30 a.m. and began its tour immediately. A highlight of the trip was the unveiling of the 25,000,000th suspension insulator manufactured at that plant. George L. Draffan, president of the company, pointed out that the basic design of the unit has been unchanged from that of the original one-piece petticoat-type cap and pin suspension insulator produced in 1911.

Production of insulators was traced through the plant from the clay in the box car to the finished insulators in crates, ready for shipment. Laboratories where tests are made to give desired control and uniformity of product also were inspected. The high-voltage test laboratory where dry and wet flashover tests were performed was a special point of interest.

Texas A&M Is Host to District 7 Student Meeting

The Agricultural and Mechanical College of Texas, College Station, Tex., its Branch officers, and counselor were host to the District 7 (South West) Student convention for 1948 which was held April 19–20, 1948. W. W. Ward, chairman of the school's Branch was the presiding officer for the meeting. Some 100 delegates and counselors representing all the 15 colleges in the District attended.

The convention started with registration Sunday evening, Student papers were presented Monday and Tuesday morning, and a picnic was held at Bryan City park on Monday evening. A counselor's luncheon was served in the board of directors' rooms, and a chairman and chairman-elect luncheon was served at the Aggieland Inn Tuesday noon. The women present were served lunch with the Corps of Cadets and later inspected the facilities of Duncan mess hall.

Tuesday afternoon, members of the convention inspected the college facilities including the a-c network calculator and mass spectrometer. After reviewing the Corps of Cadets, the convention members attended a banquet on Tuesday evening. Principal speaker was professor J. Wheeler Barger of the agricultural economics department of the school. Winners of the Student papers competition were announced. They included:

First prize to Harry F. Cooke, Arkansas University, Fayetteville, Ark., for his paper "Synchrodyne Receivers and the Locked-in Oscillator"

Second prize to R. M. Porter, Rice Institute, Houston, Tex., for his paper "A Frequency Discriminator Control for D-C Motors"

Third prize to J. E. Galloway and F. A. Tatum, Agricultural and Mechanical College, for their paper "An Oscillographic Analysis of Transformer Core Losses"

Fourth prize to R. C. Hansen, Missouri School of Mines and Metallurgy, Rolla, Mo., for his paper "A Solution to Cathode Drift in Direct-Coupled Amplifiers"

Shown here are students and counsellors attending the District 7 Student convention held at the Agricultural and Mechanical College of Texas, April 19–20, 1948

South Texas Section Meets at Buchanan Dam

With an attendance of 31 members and guests, the AIEE South Texas Section held an overnight meeting—a "weekend in the (granite) country"—at Buchanan Dam, Tex., May 1–2, 1948. The administration building of the Lower Colorado River Authority was used as a base for operations.

This building contains bedrooms and baths, a club room, dining room, and kitchen.

During the formal portion of the meeting, a paper entitled "Dielectric Heating" was presented by Student Member Earl Rhyne, after which a considerable period was devoted to discussion. This paper had been awarded first prize at a Student Branch meeting on April 12, 1948. Other meeting activities included visits to the more-than-a-mile-long dam and the hydroelectric plant, as well as swimming, boating, fishing, and walks among the surrounding granite hills.

Philadelphia Section Reports Success of Women's Auxiliary

According to a recent report by W. R. Clark, chairman of the AIEE Philadelphia Section, the recently formed women's auxiliary of the Philadelphia Section has proved of very useful and helpful assistance to the activities of the Section, and it is believed that a short résumé of the auxiliary's brief history might be of value to other Sections interested in forming a similar group. This unit is a completely separate organization and does not receive financial support from the Section.

In December 1947 the Philadelphia Section appointed a women's committee to investigate the need for and the possibilities of forming a women's auxiliary. This committee mailed a questionnaire to the women of the immediate families of the Philadelphia Section members to determine possible interest in the auxiliary, stating that the present function of the auxiliary would be to further social contact among its members and to co-operate with the various committees of the Philadelphia Section when so requested. Of the first 55 questionnaires returned, 44 gave a favorable response to its formation.

Based on this favorable response, the committee decided to form the auxiliary, and an introductory tea was held on April 1, 1948, at the Engineers' Club of Philadelphia. Of the 60 women who attended, 57 joined the auxiliary, election of officers was held, and plans for the year, based on the responses to the questionnaire, were reviewed. It was decided to hold four or five activities per year—one for the purpose of raising funds. This latter activity was accommodated by a card party on May 3, 1948, at the Engineers' Club of Philadelphia.

64th Summer General Meeting Held in Mexico City, June 21–25

Further emphasis was given to the international nature of the AIEE through the holding of the 64th annual summer general meeting in the capital city of the United States of Mexico, June 21–25, 1948. This meeting in Mexico City represents the greatest distance outside the borders of the continental United States of America to which any AIEE general meeting ever has been carried, a distance of more than 750 miles south of the Rio Grande. Upon four previous occasions the summer general meeting has been held outside the United States, the meetings of 1922, 1930, 1941, and 1947 having been held in Canada. In addition, the Pacific general meeting, which circulates from year to year among the various Sections of District 8, District 9, and the western portion of District 10, has been held in Vancouver, British Columbia, Canada, in 1913, 1922, 1932, and 1942.

Most of the many unique features associated with the Mexico City meeting were elaborated upon in the advance news reports which have appeared during the past several months in *ELECTRICAL ENGINEERING*, and for the most part will not be repeated in this report. Technical sessions and related activities were centered at the Teachers' College situated some two or three miles from the average of the several hotels which housed the majority of visiting AIEE members and guests. Transportation was principally by taxicab, by individuals and groups. With the exception of the Friday morning sessions, all technical sessions were scheduled to begin at 4:00 o'clock in the afternoon and to extend to 6:30. In view of the time and distance factors involved, and in view of the interest-competition offered by the many interesting sight-seeing and inspection trips available, attendance at most technical sessions was reasonably good.

Registration and administrative activities were centered at the Del Prado Hotel right in the center of the business district and close by the Palace of Fine Arts where the opening "inauguration" ceremony was held Monday morning. For the convenience of guests arriving Sunday morning June 20, supplementary registration centers were provided by the local committee at several of the major hotels, for this first day only. A supplementary registration center also was maintained at the Teachers' College during the course of the week.

The verified registration totaled 1,074 members and guests, an analysis of which is given in an accompanying tabulation.

The formal program included 19 regular technical sessions, 2 administrative conferences, the official annual business meeting of the Institute, and the special opening inauguration ceremony presided over by President Miguel Aleman of the United States of Mexico. This program provided for the presentation and discussion of some 53 technical program papers and 1 conference paper. It was embellished further by several motion pictures on technical subjects which were integrated with the programs of the various sessions.

Analysis of Registration at 1948 Summer General Meeting

	Districts												
Classification	Mexico	1	2	3	4	5	6	7*	8	9	10	Elsewhere	Total
Members	66	34	47	33	37	66	9	69	30	11	14	5	421
Men guests	209	9	18	7	4	14	2	144	2	2	1	3	415
Women guests	15	23	37	20	15	35	6	31	23	13	5	3	226
Students	3	1	1			3		4					12
Totals	293	67	103	60	56	118	17	248	55	26	20	11	1,074

* Except Mexico.

Registration at Recent Summer Meetings

Year	Location	District	Registration
1948	Mexico City	7	1,074
1947	Montreal	10	1,451
1946	Detroit	5	1,351
1945	Not held		
1944	St. Louis, Mo.	7	1,142
1943	Cleveland, Ohio	2	1,179
1942	Chicago, Ill.	5	1,173
1941	Toronto, Ontario, Canada	10	1,204
1940	Swampscott, Mass.	1	1,010
1939	San Francisco, Calif.	8	945

INAUGURATION CEREMONY

The outstanding colorful feature of the summer general meeting in Mexico City was the opening "inaugural" ceremony held in the beautiful auditorium of the Palace of Fine Arts, Monday morning, June 21. At the speakers' table in the center of the stage for this occasion were His Excellency, President Miguel Aleman of the United States of Mexico, President Blake D. Hull of the AIEE, and President Oscar R. Enriquez of the AIEE 64th summer general meeting committee. The other notable personages grouped on the stage included: the distinguished members of the cabinet of the Mexican Federal Government, Secretary of National Economy Antonion Ruiz Galindo, Secretary of Foreign Relations Jaime Torres Bodet, Secretary of Communications and Public Works Agustin Garcia Lopez, Secretary of Hydraulic Resources Adolfo Orive de Alba, Secretary of Public Education Manuel Gual Vidal; His Excellency, Fernando Casas Aleman, mayor of the city of Mexico and governor of the Federal District; His Excellency, Senator Eugenio Prado, president of the senate of the Republic of Mexico; AIEE President-elect Everett S. Lee; AIEE Secretary H. H. Henline; Vice-President R. F. Danner of the AIEE Southwestern District; and other AIEE and Mexican government officials.

Acting as master of ceremonies, Mr. Enriquez delivered the official address of welcome on behalf of the Mexico Section and the summer general meeting committee. Mayor Aleman gave the official address of welcome on behalf of the city of Mexico and the Federal District. President Blake D. Hull responded on behalf of the Institute. Following these addresses, President Miguel Aleman made a brief statement of welcome on behalf of the Republic of Mexico, and declared to be officially in session the "64th general congress of the American Institute of Electrical Engineers."

Much of color, dignity, and reserved air of festivity was lent to the occasion of this unusual opening session by the presence of a large military guard of honor which formed a cordon along each side of the official entrance to the Palace of Fine Arts, extending from the street in front of the building up the sweeping stairways and across the reception hall to the

Group at the inauguration ceremony of the 1948 AIEE summer general meeting in Mexico City. Left to right: Senator Eugenio Prado, president of the Senate of the Republic of Mexico; H. H. Henline, secretary AIEE; Fernando Casas Aleman, mayor of the City of Mexico and governor of the Federal District; Agustin Garcia Lopez, Secretary of Communications and Public Works of the Mexican Federal Government; Everett S. Lee, president-elect AIEE; Antonio Ruiz Galindo, Secretary of National Economy for the Mexican Federal government

entrance of the auditorium, and which performed the military rituals of honor as the presidential party entered, and again as it left, the auditorium. Also, two military bands were combined for the occasion, and gave some very fine music as a preliminary to the opening ceremonies.

ENTERTAINMENT FEATURES

Largest and best attended of the general entertainment features of the meeting was the banquet at the Del Prado Hotel, Monday noon, June 21, at which approximately 1,300 persons were present by invitation. This banquet was sponsored by Antonio Ruiz Galindo, Secretary of National Economy and by the Federal Commission of Electricity. Featured among the several who spoke at this meeting were Secretary Galindo himself, Chairman Alejandro Paez Urquidi of the Mexico Section, and Gustavo Maryssael of the local finance committee.

Tuesday noon, June 22, there was an informal luncheon meeting and social hour at the University Club, arranged for the convenience of Section delegates and as a place of informal discussion and renewal of acquaintanceships in anticipation of the formal conference of officers, delegates, and members held later in the week.

A special reception to the AIEE board of directors was given Tuesday noon in the Municipal Council chambers of the city of Mexico by the city councilmen, with Mayor Fernando Casas Aleman presiding. In the ceremonials which were performed, members of the board were made honorary guests of Mexico City and the keys of the city were presented to President Hull. Special medals were conferred by Mayor Aleman upon President Hull and Secretary Henline designating them as "Distinguished Guests of Honor of the City of Mexico." After the ceremony, the entire party was taken to the Ambassadeur's Restaurant for a special banquet arranged by the Mexico Section in honor of the board of directors, the Mexico City officials, and the executive committee of the summer general meeting committee. Alejandro Paez Urquidi, president of the Mexico Section, presided as host. Responding to the suggestion of a Mexican AIEE member, Mayor Aleman, during the banquet, proclaimed that "the city of Mexico declares the 22d day of June as the international friendship day."

Just preceding this ceremony and banquet, a special delegation of AIEE board members and officials of the local committee placed a large memorial wreath at the Perpetual Flame in the base of the great monument to the Heroes of the Mexican Independence.

With Chairman-elect Everett S. Lee presiding, a conference session of vice-presidents and the District secretaries was held Tuesday afternoon at 4:00 o'clock at the Teachers' College, to provide opportunity for informal discussion of various AIEE problems and policies, with the special objective of enabling incoming AIEE national and District officers to pick up the threads of current AIEE work and thus maintain a better continuity.

A reception and buffet supper had been scheduled to be given by Secretary of Hydraulic Resources Adolfo Orive de Alba, Wednesday evening, June 23, at the Hotel Del Prado. However, as a mark of respect to Secretary and Mrs. Alba, in view of the recent death of the secretary's mother, the reception was cancelled by the general committee.

Final and principal formal social event on the program was the reception to President Hull and the related banquet and grand ball at the Mexico City country club, Thursday evening, June 24. This was a subscription affair and the attendance was approximately 500. Feature speaker of the evening was the Honorable Walter Thurston, United States ambassador to Mexico, who discussed various aspects of the foreign policy of the current Washington administration. Other speakers included: Antonio Carrillo Flores, director of Nacional Financiera, S. A.; Louis Legorreta, director of Banco Nacional de Mexico, S. A., and president of Industria Electrica de Mexico, S. A.; and Gustavo P. Serrano, president of the Mexican Mine Association.

RESOLUTION OF APPRECIATION

As the concluding feature of the banquet program, Secretary Henline read the following resolution which had been adopted the day before by the board of directors at its regular meeting:

> Whereas, this 64th annual summer general meeting of the American Institute of Electrical Engineers has convened in the capital of the United Mexican States and
>
> Whereas, the many courtesies extended to the members have made this meeting one of the most notable in the 64 years' history of the Institute, and
>
> Whereas, all those attending the meeting have been deeply impressed by the technical and industrial progress so evident in this great nation, now therefore
>
> Be It Resolved
>
> That the board of directors of the Institute do hereby express on behalf of the members and their guests deep appreciation and gratitude:
>
> To His Excellency Senor Licenciado Miguel Aleman, president of the United Mexican States for the inspiration vouchsafed at the opening session and for his interest in the success of this congress:
>
> To the distinguished members of his cabinet for their generous personal participation, particularly His Excellency Senor Jaime Torres Bodet, Secretary of Foreign Relations, His Excellency Senor Antonio Ruiz Galindo, Secretary of Economy, His Excellency Senor Licencardo Manuel Gual Vidal, Secretary of Public Education, His Excellency Senor Ing. Adolfo Orive Alba, Secretary of Hydraulic Resources, and his Excellency Senor Agustin Garcia Lopez, Secretary of Communications and Public Works, for their most valued co-operation and support of this congress:
>
> To the governor of the Federal District, Senor Licencardo Fernando Casas Aleman for the hearty welcome to this Congress, for the generous hospitality of this great city and the honors conferred;

President Hull in conversation with Antonio Ruiz Galindo, Secretary of National Economy in the Mexican Federal Government, and Alejandro Paez Urquidi, Secretary of Economics, at the banquet Monday noon, June 21, sponsored by Secretary Galindo at the Hotel Del Prado, during the 1948 summer general meeting

To the Federal Electricity Commission, particularly Senor Ing. Alejandro Paez Urquidi, executive director, for their generous hospitality;

To the officials and personnel of the local industrial, commercial, and public utility organizations for their co-operation in the planning and conduct of the many activities; and

To the chairman Oscar R. Enriquez and the entire personnel of his committee for their long and arduous work in planning the arrangements which have led to the success of this congress.

Unanimously adopted by the board of directors of the American Institute of Electrical Engineers this 24th day of June, 1948.

Presidential procession leaving the Palace of Fine Arts in Mexico City at the close of the ceremonies marking the inauguration of the 64th annual summer general meeting of the AIEE in Mexico City, Monday, June 21, 1948. In the center at the head of the procession is His Excellency Miguel Aleman, president of the United States of Mexico; at President Aleman's right is Oscar R. Enriquez, president of the AIEE summer general meeting committee; at President Aleman's left is President Blake D. Hull of AIEE. The military guard of honor solidly flanked the line of march from the curb line at the street to the main entrance doors of the auditorium deep in the building

President Miguel Aleman of the United States of Mexico, at the moment of his official declaration from the stage of the auditorium in the Palace of Fine Arts in Mexico City, inaugurating the AIEE 64th annual summer general meeting. At the left, Oscar R. Enriquez, president of the summer general meeting committee; at the right, AIEE President Blake D. Hull

The technical sessions were brought to a formal close just before noon on Friday at a special assembly at the Teachers' College where Secretary of National Economy Antonio Ruiz Galindo made a formal closing speech on behalf of the Mexican government. The final social affair was held Friday evening in the official quarters of the Secretary of Foreign Relations where Secretary and Mrs. Torres Bodet were host and hostess respectively at a reception.

Other general entertainment features especially arranged for AIEE members and guests included a concert given Monday evening in the auditorium of the Palace of Fine Arts by the Symphonic Orchestra of Mexico under the direction of Maestro Carlos Chavez; a women's reunion, afternoon tea, and colorful fashion exhibit of native Mexican costumes, given at the University Club, Tuesday afternoon; a shopping tour Wednesday morning, for the women, sponsored by the women's division of the general committee; a special exhibition of typical regional Mexican dances in native costumes given Wednesday evening in the auditorium of the Palace of Fine Arts under the auspices of the Ministry of Public Education and the Civic Department of the city of Mexico; a motion picture lecture presenting a visual history of the growth of Paracutin Volcano given in the auditorium of the Teachers' College Thursday afternoon by Doctor Ezequiel Ordonez; a roping contest and amateur bull fight staged Friday afternoon by the National Federation of Charros in collaboration with the AIEE Mexico Section.

A total of some 40 organized inspection trips and sight-seeing trips, arranged at special prices for the benefit of AIEE members and guests, was planned by the general committee. Sixteen such trips were offered for Tuesday, June 22; seven for Wednesday, June 23; 15 for Thursday, June 24; and 2 for Friday, June 24. These trips included scenic and historical points of interest in and around Mexico City including the famous floating gardens at Xochimilco and the pyramids of San Juan Teotihuacan, and ranging as far afield as the cities of Puebla, Cuernavaca, and Taxco. A great many of the sight-seeing trips were arranged in conjunction with visits to the many local industrial plants, hydroelectric developments, water supply and sanitary plants, and other points of technical interest. In general, each day's program offered some duplicate trips so that a person could select a different trip for each day. All trips started out fairly early in the morning, and all but the longer field trips were terminated back in Mexico City in time for attendance at the afternoon sessions.

COMMITTEES

The smooth functioning of the summer general meeting in Mexico City, notwithstanding its heavy and relatively complex program, and the extent and variety of special features arranged for the meeting by the local committee, stood out as testimony to the amount of work done over a period of many months by the many people who made up the summer general meeting committee which functioned under the leadership of Oscar R. Enriquez.

General Committee: Oscar R. Enriquez, *president;* Hector Martinez D'Meza, *vice-president;* William H. Taylor, *secretary;* Federico A. Nava, *treasurer;* Basil Nikiforoff, *chairman, general technical program committee;* Manuel M. de Lascurain, *chairman, general attention committee;* Rafael Rangel, *chairman, general service committee*

Finance Committee: G. Maryssael, J. de la Macorra

Papers Committee: A. Paez Urquidi, G. Solis Payan

Hotel Accommodations Committee: P. Barona Soto, J. Rivera S.

Trips and Sports Committee: A. Enrile, C. A. Plumb

Transportation Committee: B. E. Arias, A. Carrion

Registration Committee: A. Christlieb, R. H. Eberstadt

Sessions Committee: G. B. Doughman, A. Bourlon

Technical Visits Committee: B. Nikiforoff, C. Santacruz

Hospitality Committee: E. del Valle G., M. M. de Lascurain

Ladies Committee: Mrs. Lascurain, Mrs. Plumb, Mrs. Nikiforoff

Information Committee: E. Nieto Palacios, R. Rangel

Publicity Committee: Alfredo Christlieb, E. Rodriguez Mata

Special Co-ordinating Committee: C. S. Purnell, *chairman;* R. F. Danner; J. E. Hobson; R. K. Honaman; H. M. Turner

AIEE 64th Annual Meeting Held in Mexico During the Summer Meeting

Under the chairmanship of President Blake D. Hull, the Institute's 64th annual business meeting was called to order at 10:15 o'clock on the morning of Wednesday June 23, 1948, in the auditorium of the Teachers' College in Mexico City during the summer general meeting.

SECRETARY'S REPORT

Secretary H. H. Henline presented a brief résumé of the annual report of the board of directors and called attention to the fact that printed copies of the report were available in the meeting hall and that the report subsequently would be published in full in *ELECTRICAL ENGINEERING* (see pages 804–25 elsewhere in this issue).

Secretary Henline also presented a report of the committee of tellers covering the vote of the membership on the proposals for the revision of the AIEE constitution as submitted to the membership under date of February 24, 1948, stating that the votes represented by the 11,132 ballots received were distributed as follows:

Amendment	For	Against	Invalid and Not Voted
1...To provide for five Fellow signatures on transfer "Proposal Form"	9,851	1,165	126
2...To provide for admission Associate grade from joint Student Branches	10,377	386	109
3...Doing away with "Life Membership"	8,794	1,932	146
4...Provides necessary time to prepare and mail ballots	10,689	74	109
5...To provide for filling vacancy in the office of junior past president	10,589	148	135
6...To provide for changing "convention" to "general meeting"	10,481	278	113
7...Same as amendment 6	10,433	246	193
8...To provide for board of directors representation on co-ordinating committees	10,439	248	185
9...Same as amendment 6	10,436	243	193
10...Same as amendment 6	10,426	247	199

Accordingly, President Hull declared that the constitutional changes as voted upon would become effective immediately.

TREASURER'S REPORT

In the absence of Treasurer W. I. Slichter, Secretary Henline presented the treasurer's report on behalf of Mr. Slichter, reminding his audience that, although the report covers the same income, disbursements, assets, and assessments of the Institute as does the detailed report of the auditors, Treasurer Slichter watches all these items independently and presents his own report as shown in the following:

Annual Report of the Treasurer for the Fiscal Year, May 1, 1947, to May 1, 1948

	1947–48	1946–47
Receipts for the year	$636,087.96	$593,590.22
Out of Pocket Disbursements	678,609.75	537,135.76
Deficit	42,521.79	
Excess		56,454.46
Transferred to surplus		154,766.60
Transferred from surplus	60,000.00	
Assets		
Book value of all securities	534,223.30	609,945.36
Cash in restricted funds	39,523.48	23,488.62
Cash in working funds	22,394.58	6,883.37
Total assets	$604,591.91	$640,317.35
Investments		
Book value of all securities	$534,223.30	$609,945.36
Market value, May 1	555,516.78	629,189.88

1948–49 OFFICERS INDUCTED

Secretary Henline presented the official report of the committee of tellers, in the absence of a representative of that committee which consisted of seven members of the New York Section: H. B. Margolis, *chairman;* D. E. Sullivan; G. M. Smith; E. J. Balsdon; L. G. McDowell; F. C. Roberts; and Alfred Kahn. According to the report, a total of 9,354 had been received of which 21 were invalid because of receipt after June 1, 1948, 57 were invalid because of dues arrearage to May 1, 1948, and 97 were invalid by virtue of not bearing the identifying signature of the voting member. This left a total of 9,179 valid ballot envelopes, on the basis of which President Hull declared the following list of new Institute officers duly elected for the administrative year which begins August 1:

1. President
Everett S. Lee, of the Schenectady Section

2. Vice-Presidents
Victor Siegfried, of the Worcester, Mass. Section, for District 1—North Eastern
J. L. Callahan, of the New York Section, for District 3—New York City
Ira A. Terry, of the Fort Wayne Section, for District 5—Great Lakes
G. N. Pingree, of the Dallas Section, for District 7—South West
Richard McKay, of the Spokane Section, for District 9—North West

3. Directors
C. W. Fick, of the Cleveland Section
M. D. Hooven, of the New Jersey Division of the New York Section
F. O. McMillan, of the Portland Section

4. Treasurer
W. I. Slichter, of the New York Section

These new officers, together with the following holdover officers, will constitute the AIEE board of directors for the administrative year which begins August 1, 1948:

B. D. Hull of Dallas, Texas (retiring president); J. Elmer Housley of Alcoa, Tenn. (junior past president); G. W. Bower of the Philadelphia Section; J. H. Berry of the Virginia Section; I. M. Ellestad of the Nebraska Section; D. I. Cone of the San Francisco Section; D. G. Geiger of the Toronto Section; W. L. Everitt of the Urbana Section; J. F. Fairman of the New York Section; J. M. Flanigen of the Atlanta Section; R. T. Henry of the Buffalo Section; A. C. Monteith of the Pittsburgh Section; J. R. North of the Michigan Section; Elgin B. Robertson of the Dallas Section; Walter C. Smith of the San Francisco Section; E. P. Yerkes of the Philadelphia Section

President Hull called Mr. Lee to the platform, pinned upon his lapel the official gold AIEE emblem of his new office, and formally introduced him as AIEE president for the administrative year 1948–49. The full text of Mr. Lee's remarks in response to this introduction, giving a preview of his intended philosophy and procedure as president of the AIEE for next year, are given elsewhere in this issue (*page 777*).

INSTITUTE PRIZES AWARDED

The winners of the 1947 national prize awards for technical papers were announced by Professor H. M. Turner of the New Haven Section, chairman of the committee on award of Institute prizes, and also chairman of the technical program committee. Each such national prize award consists of $100 in cash and an appropriately embossed certificate, the cash award being divided where there are two or more coauthors. For 1947, Professor Turner named the following winners:

Best Paper in the Field of Engineering Practice. Prize awarded to J. R. Davey (nonmember) and A. L. Matte (M '36) of the New York Section (Bell Telephone Laboratories, Inc.) for their paper entitled "Frequency Shift Telegraphy—Radio and Wire Applications," paper presented originally at 1947 winter general meeting in New York. Honorable mention was awarded to Giuseppe Calabrese (M '40) of the New York Section (Consolidated Edison Company of New York, Inc.) for his paper "Generating Reserve Capacity Determined by the Probability Method," which was presented originally at the 1947 Midwest general meeting in Chicago.

Best Paper Prize in the Field of Theory and Research. Prize awarded to H. C. Roters (M '42) of the New York Section (Fairchild Camera and Instrument Corporation) for his paper "The Hysteresis Motor—Advances Which Permit Economical Fractional Horsepower Ratings," which was presented originally at the 1947 Middle Eastern District meeting in Dayton, Ohio.

Prize for Initial Paper. Prize awarded to Hamilton Brooks (M '46) of the Pittsburgh Section (Westinghouse Electric Corporation) for his paper "The Probable Breakdown Voltage of Paper Dielectric Capacitors," which was presented originally at the 1947 summer general meeting in Montreal.

Prize for Branch Paper. Prize awarded to J. R. McDade of the Student Branch at Southern Methodist University for his paper entitled "The Phantastron Single-Tube Control Circuit," which was presented at the South West Student Branch conference held at the University of New Mexico on May 6, 1947. Honorable mention was awarded to Dale Rummer of the Student Branch at Kansas University, for his paper entitled "Theory and Operation of Electric Machines for Solving Linear Equations," which was presented at the Student Branch meeting held at Kansas University, April 16, 1947.

None of the prize winners was present to receive the award in person.

AIEE LAMME MEDAL PRESENTED

Past-president A. M. MacCutcheon (F '26) of the Cleveland Section received the 1947 AIEE Lamme Medal "for his distinguished accomplishments in the development of motors for industrial needs, notably in the steel industry." President Hull made the presentation.

Prior to the presentation, a review of the establishment and history of the medal was given by Vice-president T. G. LeClair of the Chicago Section. Also, a biographical outline of Mr. MacCutcheon's professional career was given by F. E. Harrell, past chairman of the Cleveland Section.

Medalist MacCutcheon responded to the presentation with an address entitled "Co-operative Engineering." All three addresses appear elsewhere in this issue of *ELECTRICAL ENGINEERING* (*pages 749–53*).

AIEE AFFAIRS DISCUSSED BY HULL

In his presidential valedictory address, President Blake D. Hull launched into a searching discussion of various current AIEE operating and administrative problems. The full text of Mr. Hull's address appears on page 776 of this issue.

New Officers Elected at AIEE Summer General Meeting

At the annual meeting of the Institute which was held in Mexico, Federal District, Mexico, June 23, 1948, the following officers for the year beginning August 1, 1948, were announced:

President: Everett S. Lee, engineer in charge of the general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y.

Vice-presidents: Victor Siegfried, chief research engineer, electric cable works, American Steel and Wire Company, Worcester, Mass. (District 1, North Eastern); John L. Callahan, assistant to director, radio systems research laboratory, Radio Corporation of America, RCA laboratories division, and assistant to vice-president in charge of research and development, RCA Communications Inc., New York, N. Y. (District 3, New York City); Ira A. Terry, assistant manager of engineering, fractional horsepower motor divisions, General Electric Company, Fort Wayne, Ind. (District 5, Great Lakes); George N. Pingree, transformer specialist, General Electric Company, Dallas, Tex. (District 7, South West); Richard McKay, assistant general manager, The Washington Water Power Company, Spokane, Wash. (District 9, North West).

Directors: Clarence W. Fick, district manager, apparatus department, Cleveland Ohio; Morris D. Hooven, electrical engineer, electric engineering department, Public Service Electric and Gas Company, Newark, N. J.; F. O. McMillan, professor and head of the electrical engineering department, Oregon State College, Corvallis, Oreg.

Treasurer: W. I. Slichter, professor emeritus of electrical engineering, Columbia University, New York, N. Y. (re-elected).

The board of directors for the administrative year beginning August 1, 1948, will consist of these newly elected officers and the following holdover officers:

Blake D. Hull, Dallas, Tex. (*retiring president*); J. Elmer Housley, Alcoa, Tenn. (*past president*); J. H. Berry, Norfolk, Va.; G. W. Bower, Haddonfield, N. J.; D. I. Cone, San Francisco, Calif.; I. M. Ellestad, Omaha, Nebr.; W. L. Everitt, Urbana, Ill.; J. F. Fairman, New York, N. Y.; J. M. Flanigen, Atlanta, Ga.; D. G. Geiger, Toronto, Ontario, Canada; R. T. Henry, Buffalo, N. Y.; A. C. Monteith, East Pittsburgh, Pa.; J. R. North, Jackson, Mich.; Elgin B. Robertson, Dallas, Tex.; Walter C. Smith, Palo Alto, Calif.; E. P. Yerkes, Philadelphia, Pa.

The annual report of the board of directors, presented at the meeting, showed a total membership on April 30, 1948, of 28,400. In addition to the winter, summer, Pacific, and Midwest general meetings, and three District meetings, 2,512 meetings were held during the year by the Sections and Student Branches.

PERSONAL NOTES.......

H. C. Coleman (A '18, M '28) manager of the marine and aviation section of the industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been appointed chairman of the AIEE general applications co-ordinating committee for 1948–49. Born at Footville, Ohio, he was graduated in 1916 from Ohio State University with a degree of bachelor of electrical engineering. In that year he entered the graduate student course of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., and in 1917 became an electrical engineer in the general engineering division of that company, engaged in application work on electric apparatus for marine service. His early experience was obtained in the application of electric equipment to submarines of the United States Navy. He later specialized on Diesel-electric ship propulsion and auxiliaries. In 1927 he was appointed manager of marine electrical engineering and has assisted in the designing, manufacturing, installing, and testing of ship stabilizers of the gyroscopic type of submarine and battleship electric propelling plants and auxiliaries, and of Diesel-electric and turbine-electric propelling equipment for a large number of ships of all classes. He has served on the AIEE committee on applications to marine work, and was chairman of the committee for 1933–34. He is a member of the Society of Naval Architects and Marine Engineers, the American Society of Naval Engineers, and the Propeller Club of the United States.

J. J. Orr

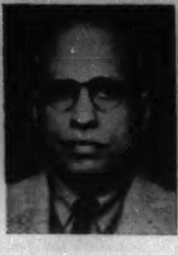
D. L. Beeman

H. C. Coleman

J. J. Orr (A '30) engineer, central staff, United States Rubber Company, New York, N. Y., has been appointed chairman of the AIEE industry co-ordinating committee for 1948–49. Born April 9, 1902, at Manistique, Mich., he studied engineering at the University of Michigan. He was employed by the Oakland Motor Car Company, Pontiac, Mich., as an electrician in 1919–20 and as a draftsman 1924–26. When the company became the Pontiac division of General Motors Corporation in 1926, he became an assistant electrical engineer, and in 1928 he became electrical engineer. During 1930–31 he was plant manager for A. J. Brandt, Inc., a construction engineering firm in Detroit, Mich. He joined the staff of the United States Rubber Company, New York, in 1932, as electrical engineer. In 1933 he was transferred to Providence, R. I., as plant engineer, and in 1936 was made manager of planning and engineering at Providence. He was appointed to the central engineering staff in 1938. He was a member of the AIEE committee on industrial power applications from 1937 to 41, and also has been a member of the co-ordinating committee of the Standards committee, as well as the publication committee for 1947–48.

D. L. Beeman (A '31) industrial engineering division, General Electric Company, Schenectady, N. Y., has been made chairman of the AIEE industrial power systems committee for 1948–49. He received the degree of bachelor of arts in electrical engineering from Stanford University in 1929, and immediately entered the employ of the General Electric Company in the test course as student engineer. He was engaged subsequently on test work at that company's plants in Pittsfield, Mass., and Philadelphia, Pa., and later was transferred to the relay-engineering division of the switchgear department in Philadelphia. In 1935 he joined the air-circuit-breaker engineering division there, and in 1936 he transferred to the central station engineering department at Schenectady, N. Y. He was an application engineer in the industrial power section from 1941 to 1943, and in 1943 he was appointed engineer of the industrial power section.

F. C. Willis (A '22, M '28), formerly associated with the Bell Telephone Laboratories, Inc., New York, N. Y., has retired. He joined the engineering department of the Western Electric Company in 1913 and was assigned to the physical laboratories. From 1914 to 1919 he served with the British Army on leave of absence. Returning to the apparatus development department in 1919, he worked as a design engineer with the radio development group on ship-to-shore com



S. N. Bose

M. L. Foote

W. H. Harrison

A. S. Basil

H. H. Weber

munications and later on laboratory and testing apparatus. In 1928 he joined the Electrical Research Project, Inc., as a recording engineer, becoming a supervisor of electrical and acoustical engineering projects in connection with recording sound on film and on disks. He also worked to develop long playing disk recordings used throughout World War II as a security measure. Returning to the Bell Laboratories in 1941, he engaged in various phases of air-borne radar developments in the specialty products development department. During the war he was a project engineer, developing widely used radar equipment, and went to Europe in an advisory capacity with this equipment. He served on the AIEE Standards committee from 1942 to 1946.

W. H. Harrison (A '20, F '41) formerly vice-president in charge of operations and engineering of the American Telephone and Telegraph Company, New York, N. Y., has been elected president of the International Telephone and Telegraph Corporation, New York. General Harrison had entered the employ of the New York Telephone Company in 1909, then was successively with the Western Electric Company and the American Telephone and Telegraph Company, rising to a vice-presidency. On leave of absence from the company in 1940 he became head of the production division of the War Production Board, Washington, D.C., and two years later was commissioned a colonel in the Army of the United States. Subsequently he rose to the rank of major general. General Harrison returned to the company in 1945 and was awarded the AIEE Hoover Medal for that year in recognition of distinguished public service. He is a past-president (1937–38) of the Institute, was a member of the board of directors from 1935 to 1940, and has served on many AIEE committees.

S. N. Bose (A '13, F '48) formerly with the Tata Iron and Steel Company, Ltd., of Jamshedpur, India, as assistant chief electrical engineer, deputy chief electrical engineer, and, for 17 years, as chief electrical engineer, has retired from their services to join the government of West Bengal, where he will serve as chief electrical engineer of the Electricity Development Directorate. Educated at Allahabad University and B. J. Technical Institute in Bombay, India, he later studied at Cornell University where he was elected Eta Kappa Nu. His career began with the East Indian Railway Company, Jamalpur, India, after which he spent 17 years in the United States, associated with General Electric Company, The Pennsylvania Railroad Company, New York, N. Y., the Cazenovia (N. Y.) Electric Company, and the J. G. White Engineering Corporation, New York. He returned to India in 1926.

Marie Lovett Foote (A '47, Life Member) has resigned as assistant editor on the staff of the AIEE publications department, New York, N. Y., and has announced her marriage to Lieutenant K. D. Reel, United States Army. A native of Brewton, Ala., Miss Foote was graduated from Duke University with a degree of bachelor of science in electrical engineering in 1946, then became an editorial assistant on the AIEE staff. While an undergraduate she was an AIEE Student Member, and served as treasurer of the AIEE Student Branch at Duke University and was a member of the circulation staff of the *Duke Engineer*. She is a member of Phi Beta Kappa.

K. M. Irwin (M '46) manager of engineering, Philadelphia (Pa.) Electric Company, has been named vice-president in charge of engineering. A graduate of Sheffield Scientific School of Yale University in 1915, he served in the United States Navy during World War I before joining the United Gas Improvement Company as a mechanical engineer. He transferred to the Philadelphia Electric Company in 1931, and subsequently was appointed manager of the engineering department. During World War II he was executive director of the London, England, staff of the Public Utility Committee of the Combined Production and Resources Board, and in this capacity made important contributions to the restoration of utility service in northwest Europe.

H. H. Hausner (M '40) has been appointed a member of the staff of the Metallurgical Research and Development Laboratory of Sylvania Electric Products, Inc., New York, N. Y. Educated at the University of Vienna, he formerly was associated with prominent electrical engineering organizations in Europe and has been associated with the Ceramics and Steatite Corporation, the Nichols Research and Engineering Corporation, the United States War Department, and the American Electro Metals Corporation. He has been a research associate and professor in the graduate division at New York University, and will specialize in powder metallurgy for application to electron tubes, lighting, and special products. He is a fellow of the New York Academy of Sciences, a member of the American Ceramic Society, and the Society of Military Engineers.

G. H. Garcelon (A '10, M '13) manager, industrial control engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., will retire on September 1, 1948. Mr. Garcelon entered the employ of the Westinghouse company upon his graduation from Massachusetts Institute of Technology in 1903. Before his appointment as manager in 1931 he was manager of engineering for the company's works at East Springfield, Mass. He is well known for his work in designing small motors. He has served on AIEE committees for electric machinery (1926–27) and industrial control devices (1945–47).

T. O. Evans (A '41) formerly assistant superintendent engineer, has been appointed superintending engineer, stations section, Quebec Hydro-Electric commission, Montreal, Quebec, Canada.

J. W. McNairy (A '26) who has been manager of the engineering and planning division, appliance and merchandise department, General Electric Company, Bridgeport, Conn., now is manager of engineering and manufacturing for the appliance and merchandise department.

H. H. Weber (A '27, F '40) sales manager, wire and cable department, United States Rubber Company, New York, N. Y., has been appointed chief engineer of the department. A native of Allentown, Pa., he received his technical education at Lehigh University and had been employed by the Rome Wire Company and the General Cable Corporation prior to joining the United States Rubber Company in 1934.

A. S. Basil (M '46) formerly chief engineer of the wire and cable department of the United States Rubber Company, New York, N. Y., has been appointed general sales manager. He has been with the company since 1926, when he was graduated from Rensselaer Polytechnic Institute.

OBITUARY

John Mills (A '11, M '12, F '23) retired director of publications of the Bell Telephone Laboratories, Inc., New York, N. Y., died June 14, 1948. Born in Morgan Park, Ill., in 1880, he received his bachelor of arts degree from the University of Chicago in 1901, a master of arts from the University of Nebraska in 1904, and a bachelor of science degree from the Massachusetts Institute of Technology in 1909. After teaching at Massachusetts Institute of Technology and the University of Colorado he entered the employ of the American Telephone and Telegraph Company, New York, in 1911 as a transmission engineer. In 1916 Mr. Mills transferred to the development and research department of the Western Electric Company, which later became the Bell Telephone Laboratories. While still working with the American Telephone and Telegraph Company he was concerned with the planning and arranging for the early radio telephone experiments for that company and Western Electric Company in long distance telephony. During the next six years he devoted himself to radio transmission and in the first World War period he conducted a radio training course. He served as director of personnel of the laboratories from 1921 to 1925, when he was appointed director of publications. In this position he planned the Bell System's exhibit at the World's Fairs in Chicago in 1933 and in New York and San Francisco in 1939. He was especially interested in bringing the idea of audience participation into displays of scientific advances whose design and installation he supervised. An author of many scientific and engineering texts, Mr. Mills was a pioneer in science writing for the layman. His work, "Within the Atom," was widely read in the 1920's. His other books include "Electricity, Sound and Light," "Introduction to Thermodynamics," "Alternating Currents," "Radio Communication," "Realities of Modern Science," "Letters of a Radio Engineer to His Son," "Signals and Speech in Electrical Communication," "A Fugue in Cycles and Bels," "Electronics, Today and Tomorrow," and "The Engineer in Society." He planned the magazine *Bell Laboratories Record* as a medium for describing the research and development work of the laboratories. Following his retirement in 1945 Mr. Mills served as an adviser to undergraduates at the California Institute of Technology, Pasadena. Mr. Mills was a member of Phi Beta Kappa, Sigma Xi, and Delta Upsilon, and was a fellow of the Institute of Radio Engineers and the American Physical Society. His AIEE committee activities include service on meetings and papers (1922–24), education (1926–28), communication (1930–35), and publication (1941–46).

James A. Powell (M '31) chief mechanical engineer of the Stone and Webster Engineering Corporation, Boston, Mass., died June 9, 1948. Mr. Powell was born in Raleigh, N. C., December 24, 1888. He was graduated from North Carolina State College with the degree of bachelor of engineering in 1908 and was awarded a master's degree three years later. Mr. Powell also was awarded an honorary degree of doctor of science in 1933. He was a member of Tau Beta Pi and Phi Kappa Phi. After brief employment as a structural draftsman in the office of H. P. S. Keller in Raleigh, he became an apprentice engineer with the Westinghouse Machine Company in Pittsburgh, Pa., assuming the title of engineer in 1913. In 1917 he was employed as mechanical engineer by W. P. Barstow Management Association and a year later became assistant manager and chief engineer of the Elliott Company. He returned to the Barstow organization a year later as assistant chief engineer and vice-president. In 1933 he became vice-president and assistant chief engineer of E. M. Gilbert Engineering Corporation and in 1938 vice-president of The Utility Management Corporation. In 1941 he came to Boston as mechanical engineer for Stone and Webster and became chief mechanical engineer in 1945. Mr. Powell achieved an international reputation as a designer of steam power plants, including notable installations throughout the United States and in the Philippines. He held numerous patents on power station equipment. Mr. Powell represented the United States at the last world power conference in Berlin, Germany. He served on the AIEE power generation committee from 1947 until his death. He was a member of the American Society of Mechanical Engineers and National Society of Professional Engineers.

Henry Flood, Jr. (A '10, M '21, F '30) president of the engineering firm of Flood and Watson, New York, N. Y., died June 17, 1948. He was born on February 9, 1887, in Elmira, N. Y., and attended Cornell University, graduating in 1909 with a degree in mechanical engineering. From 1910 to 1911 he was an engineer with the Penn Central Power Company, Altoona, Pa., and he was with the Central Hudson Gas and Electric Company, Poughkeepsie, N. Y., as chief engineer and assisting operating manager from 1911 to 1917. He then became a consultant in copper production problems for the American Smelting and Refining Company. In 1920 and 1921 he was engineering secretary for the United States Power Survey, just before the incorporation of the firm of Murray and Flood. From 1921 to 1942 he served as consultant to many railroads, public utilities, and manufacturers. He also was engaged during this period in the financing, design, and construction of the dam and water plant of the Lexington Water Power Company on the Saluda River, S. C., the largest earthern dam in the world at the time of its construction. The firm of Flood and Watson was formed early in 1948. He was a member of the American Society of Mechanical Engineers, of the Society of Automotive Engineers, and of the Engineers' Club of New York. He served on the AIEE Standards committee from 1924 to 1925 and from 1927 to 1928.

Harry Diamond (F '47), chief of the electronics division of the National Bureau of Standards, died June 21, 1948. He was born in Quincy, Mass., on February 12, 1900, and attended Massachusetts Institute of Technology, graduating with the degree of bachelor of science in electrical engineering in 1922. He taught at Lehigh (Pa.) University from 1923 to 1927 and received his master's degree in 1925. Joining the National Bureau of Standards in 1927 as associate radio engineer, he was radio engineer from 1928 to 1930, and from 1930 to 1936 he was senior radio engineer. In this position he was in charge of the program to develop radio aids to aviation. He was principal physicist for the Bureau from 1936 to 1942, and was chief of the Division of Ordnance Development during the war, later heading the electronics division which was concerned with ordnance work. His activities included work on aviation radio, radio meteorological observation, radio direction finding, electronic ordnances, and electronics. He organized the first completely "blind" flight and landing (1933). He was one of the chief developers of the proximity fuse for shells which was one of the most important ordnance discoveries of World War II. Mr. Diamond's many honors included the Washington Academy's award for engineering achievement, 1940; the Naval Ordnance Development Award for exceptional services, 1945; and a certificate from the War Department for outstanding service, 1945. He was a fellow of the Institute of Radio Engineers, a member of the educational board of the National Radio Institute and the American Ordnance Association, a member of the Washington Academy of Sciences, the Joint Research and Development Board, and a division member of the National Defense Research Committee. He is the author of many articles and pamphlets and had previously been a member of the AIEE from 1922 to 1930.

James Hervey Herron (M '35, F '41) president, James H. Herron Company, engineers and chemists, Cleveland, Ohio, died March 29, 1948. Mr. Herron was born January 4, 1875, in Girard, Ohio, and was graduated from the University of Michigan in 1909 with a bachelor of science degree in engineering. He served his apprenticeship with the Stearns Manufacturing Company, Erie, Pa. From 1895 to 1897 he worked as assistant and chief engineer of the Erie City Iron Works. From 1899 to 1902 he was assistant engineer in charge of power, Cambria Steel Company, Johnstown, Pa. From 1902 to 1905 he was vice-president and chief engineer of the Bury Presser Company, Erie. Before forming his own firm in 1909 he was associated with the Motch and Merriweather Machinery Company, Detroit, Mich., and with the Detroit Steel Products Company. His company was formed to do construction, inspection, testing and consultation. In 1921 and 1922 he was concerned with the design and construction of Galion (Ohio) Municipal Light and Power Plant, and in 1924 and 1925 was responsible for remodeling the light and power plant at Norwalk, Ohio. His early experience was in the design of d-c motors and generators and an application of synchronous motors to direct drive of air compressors. His later experience covered power and light plant design and installation and motor drive installation in industrial plants. He was a member of the Cleveland Engineering Society (president 1917–18), of the American Society of Mechanical Engineers (president 1936), American Society of Civil Engineers, the American Chemical Society, and a fellow of the Association for the Advancement of Science.

James P. McKearin (A '11, F '38, Life Member) chief engineer of the Western Massachusetts Electric Company, Springfield, Mass., from 1936 until his retirement in 1944, died on April 24, 1948. Mr. McKearin was born in Proctor, Vt., and studied at Dartmouth College. He was with the General Electric Company, in Massachusetts for 12 years in his earlier career, working as a construction foreman, trouble shooter, and as an assistant district engineer. In 1917 he became electrical engineer of the United Electric Light Company, Springfield, Mass., the predecessor company of the Western Massachusetts Electric Company. In 1937 a group of friends and associates honored him on the occasion of his having completed 20 years service with the Company, and his major part in transmission and distribution development, by presenting him with an AIEE life membership. He served on the AIEE committees on protective devices, 1929–37 (chairman from 1936 to 1939), and technical program, 1936–38, and was past chairman of the Springfield Section.

William Thomas Booth (A '03, M '23, Member for Life) machine switching apparatus design department, Bell Telephone Laboratories, Inc., New York, N. Y., died April 11, 1948. Born in Brooklyn, N. Y., February 21, 1879, and educated at Pratt Institute and Cooper Union receiving the degree of bachelor of science in 1905, he was designer of apparatus with the Lambert Schmidt Telephone Manufacturing Company, later the Schmidt-Wilkes Manufacturing Company, from 1900 to 1907. In 1908 he became apparatus designer at the wireless telegraph station at Brant Rock, Mass. In 1908 he joined the Western Electric Company in a supervisory capacity, and from 1911 to 1914 he was on the staff of that company's European chief engineer, stationed in Berlin, Germany, and Antwerp, Belgium. During World War I he was an engineering representative in the Signal Corps and Navy for airplane radio and field signaling sets. In 1919 he was in charge of the dial apparatus group and in 1925 worked on cost savings and special investigations. In his later career he was responsible for work associated with the Underwriters' Laboratory. He had been in retirement for five years.

John Girdlestone Glassco (A '03, F '28) retired Hydro manager of Winnipeg, Ontario, Canada, died recently. Born September 10, 1879, at Hamilton, Ontario, he was educated at McGill University, Montreal, receiving the degree of bachelor of science in 1900. He received his master of science degree for postgraduate research work in 1901, and was a demonstrator in electrical engineering in 1902. In his early career he was in the test and repair department of both the Montreal Light, Heat and Power Company, and the Southern California Edison Company. He was chief operator, Kern River development, for the Pacific Light and Power Company, and from 1905 to 1909 was chief electrical engineer for the Dominion Power and Transformer Company, Hamilton, Ontario. In 1911 he became power engineer, and in 1912, at the age of 32, he was made manager of the city Hydro, occupying that position until his retirement in 1944.

Stephen Wiley Borden (M '16) founder of the Borden Electric Company, Summit, N. J., died May 13, 1948. Born in Canning, Nova Scotia, on August 30, 1882, Mr. Borden obtained his early experience with the General Electric Company at Lynn, Mass. After seven years with the Tuxedo (N. Y.) Electric Company, he took over management of the Bassett properties in Summit, which included the Commonwealth Water and Light Company, the Lakewood and Coast Electric Company, and the Point Pleasant Traction Company. In 1923 he negotiated sale of these properties and established his own business in the conduit ground fitting field under the name of Groundulet Company, Newark, N. J. Disposing of this business in 1927, Mr. Borden formed the Borden Electric Company, for the development of his ground testing patents. More than 25 patents have been issued to him.

Henry Harding McKinney (M '47) electrical engineer, engineering department, United States Naval Station, Tacoma, Wash., died April 13, 1948. Mr. McKinney was born August 18, 1917, in Baker, Wash., and was graduated from Oregon State College in 1939 with the degree of bachelor of science in electrical engineering. He served as a lieutenant in the Navy for four years in the South Pacific. Upon his release in 1946 he was employed as a civil electrical engineer with the Navy. He was employed for a year at the Naval Air Station at Whidby Island, Wash., and for another year at the Naval Station, Tacoma, and also was associated with The Austin Company, Seattle, Wash., specializing in lighting and electrical distribution systems for the various Naval bases throughout the Pacific Northwest.

Edwin Paul Nill (A '41) test supervisor of the electrical engineering department of Consolidated Edison Company of New York (N. Y.), Inc., died May 20, 1948, after more than 20 years service with that company. Born October 2, 1902, at Watertown, N. Y., he first joined Consolidated Edison as a tester, and became junior engineer working on development of miscellaneous tools and equipment used for construction and maintenance of underground transmission and distribution systems. From 1931 to 1941 he was foreman in charge of the materials testing laboratory and from 1937 to 1941 he was a laboratory instructor in the electrical engineering department of the Cooper Union, New York. In 1946 he was named general foreman and made test supervisor.

MEMBERSHIP . . .

Recommended for Transfer

The board of examiners at its meetings of June 10 1948, and June 17, 1948, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Fellow

Ames, N. B., prof. of elec. engg., The George Washington Univ., Washington, D. C.
Brecht, W. A., mgr., transportation engg., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Darland, A. F., supervising engr., Columbia Basin project, Bureau of Reclamation, Coulee Dam, Wash.
Dickinson, R. C., mgr., power air circuit breaker sec., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Gunby, F. M., associate director, Chas. T. Main, Inc., Boston, Mass.
Jones, J. C., supt. of transmission, Florida Pr. & Lt. Co., Miami, Fla.
Kimbark, E. W., prof. of elec. engg., Northwestern Univ., Technological Inst., Evanston, Ill.
MacLeod, D. R., application engr., General Elec. Co., Erie, Pa.
Manning, M. L., chief engr., Kuhlman Elec. Co., Bay City, Mich.
Osbon, W. O., advisory engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
O'Sullivan, G. H., asst. elec. engr., The J. G. White Corp., New York, N. Y.
Sadler, E. K., chief engr., Kelman Elec. & Mfg. Co., Los Angeles, Calif.
Warren, H. E., pres., Lombard Governor Corp., Ashland, Mass.
13 to grade of Fellow

To Grade of Member

Akers, H. T., elec. design engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Armstrong, R. W., plant engr., Ludlow Mfg. & Sales Co., Ludlow, Mass.
Barkle, J. E., Jr., central station engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Barnaby, D. R. E., asst. to pres., Canadian Line Materials, Ltd., Scarboro Junction, Ontario, Canada
Bates, S. C., field engr., Bell Tel. Labs., (N. Y. C.), Cleveland, Ohio
Bhattacharyya, P. K., supt., elec. engg. & construction, Tata Iron & Steel Co., Ltd., Jamshedpur, Dehar, India
Boehmer, D., consulting elec. engr., Kearney & Trecker Corp., Milwaukee, Wis.
Bollaert, R., consulting & application engr., Westinghouse Elec. Corp., San Francisco, Calif.
Bost, W. A., elec. engr., Fagan Elec. Co., Little Rock, Ark.
Breth, J. E., elec. engr., Calumet & Hecla Consolidated Copper Co., Calumet, Mich.
Brooks, C. J., elec. engg. dept., Cleveland Electric Illuminating Co., Cleveland, Ohio
Brown, S. K., Jr., electronics engr., Naval Research Lab., Washington, D. C.
Buckland, J. L., consulting engr., 422 Little Collins St., Melbourne, Victoria, Australia
Buergey, I. J., elec. supt., Anaconda Copper Mining Co., Great Falls, Mont.
Carnie, W. B., supt. of transmission, Montaup Elec. Co., Fall River, Mass.
Cleaver, O. P., chief, technical dept. II, Engineer Research & Development Labs., Fort Belvoir, Va.
Cushing, G. B., associate engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Denison, H. M., industrial consultant, Kansas Gas & Elec. Co., Wichita, Kans.
Duffy, M. D., asst. supt. of distribution, Pacific Pr. & Lt. Co., Portland, Oreg.
Dyktor, G. J., elec. engr., Westinghouse Elec. Int'l. Co., New York, N. Y.
Ellerbeck, K. H., exchange plant extension engr., The Pacific Tel. & Tel. Co., Seattle, Wash.
Erhard, R., Jr., design engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Evers, E. P., patent attorney & consulting engr., 10545 Homestead Ave., Overland, Mo.
Farrell, J. M., owner & Operator, Carolina Elec. Supply Co., Charlotte, N. C.
Franklin, P. W., elec. engr., Eclipse-Pioneer Div. of Bendix, Teterboro, N. J.
Friedsam, S. R., Sr., chief dispatcher, Lower Colorado River Authority, Austin, Tex.
Gilsdorf, W. R., mgr., Spaulding Fibre Co., Ft. Wayne, Ind.
Gravitt, B. B., elec. engr., General Elec. Co., San Diego, Calif.
Hampton, W. C., experimental research engr., American Instrument Co., Inc., Silver Springs, Md.
Harrell, B. F., elec. engr., Naval Research Labs., Anacosta, D. C.
Hatton, W. L., asst. supt., substation dept., Potomac Elec. Pr. Co., Washington, D. C.
Hennig, W. E., pres., Electric Sales & Engg. Co., Milwaukee, Wis.
Howard, J. J., project mgr., Watson Flagg Engg. Co.; on Turbine Plant Job, New York, N. Y.
Huehnel, A. L., supv. engr., Square D Co., Milwaukee, Wis.
Joel, A. E., Jr., member of tech. staff, Bell Tel. Labs. Inc., New York, N. Y.
Johnson, C. R., chief elec. engr., General Cable Corp., Perth Amboy, N. J.
Jones, A. F., supervisor, circuit design section, Federal Tel. & Radio Corp., Clifton, N. J.
King, L. A., design & development engr., RCA Victor Dir. of RCA, Camden, N. J.
Kinney, F. M., chief designer elec. div., Pesco Products Div., Borg-Wagner Corp., Cleveland, Ohio.
Koetsier, A. J., Detroit district engg. & service mgr., Westinghouse Elec. Corp., Detroit, Mich.
Lapp, G. W., consulting engr., Lapp Insulator Co., Leroy, N. Y.
March, M. E., project engr., central engg., Chrysler Corp., Detroit, Mich.
Maxim, J. H., commercial engr., Ohio Crankshaft Co., Tocco Induction Heating Div., Cleveland, Ohio.

McClain, O. E., traffic engg., Southwestern Bell Tel. Co., Oklahoma City, Okla.
McGinty, E. A., supt. substations & transmissions, Northern Area, Pacific Gas & Elec. Co., Sacramento, Calif.
McLennan, A. J., engr., New England Power Service Co., Boston, Mass.
Ock, W. A., standards engr., Sperry Gyroscope Co., Great Neck, N. Y.
Osteen, W. C., supr., test section, Southern California Edison Co., Los Angeles, Calif.
Pearce, W. B., chief engr., Albert & J. M. Anderson Mfg. Co., Boston, Mass.
Pobst, J. W., elec. engr.; head, control devices subsection, electricity div., Naval Research Lab., Washington, D. C.
Pollack, M., research engr., Armour Research Foundation, Chicago, Ill.
Poppino, C. A., sales engr., General Electric Co., Phoenix, Ariz.
Queen, S. D., general elec. foreman, Cleveland Elec. Illuminating Co., Ashtabula, Ohio
Richardson, G. A., asst. prof. of elec. engg., Iowa State College, Ames, Iowa
Rittenhouse, J. W., instructor elec. engg. dept., Univ. of Mo., School of Mines & Metallurgy, Rolla, Mo.
Robison, H. F., engr., testing dept., Commonwealth Edison Co., Chicago, Ill.
Rubenstein, M., district mgr., Anaconda Wire & Cable Co., Washington, D. C.
Ruhl, F. L., elec. engr., aeroproducts div., General Motors Corp., Dayton, Ohio
Rundlett, T. L., section engr., Westinghouse Electric Corp., Sharon, Pa.
Rupprecht, W. J. L., supt., electrical dept., The Dow Chemical Co., Midland, Mich.
Saile, O. W., field engr., General Elec. Co., Houston, Tex.
Schuette, R. E., project engr., Barber-Colman Co., Rockford, Ill.
Sterrett, C. C., AC machine design engr., Westinghouse Elec. Corp., E. Pittsburgh, Pa.
Storm, C. P., elec. designer, Sanitary District of Chicago, Chicago, Ill.
Swenson, C. A., elec. engr., Cornell Aeronautical Lab., Buffalo, N. Y.
Tracht, J. W., chief engr., Pennsylvania Salt Mfgr. Co. Wyandotte, Mich.
Trovinger, R. E., elec. engr., Indiana Service Corp., Ft. Wayne, Ind.
Turner, H. P., application engr., Westinghouse Elec. Corp., Providence, R. I.
Vaidya, V. R., executive engr., transmission, Bombay Electric Grid, Bombay, India
VanAken, H. N., branch mgr., Akron office, Square D Co., Akron, Ohio
Weers, A. F., owner, Weers Elec. Planning Service, Denver, Colo.
Whipple, C. L., supt. hydro plants, Puerto Rico Resources Authority, San Juan, Puerto Rico
Wickey, J. R., elec. engr., The Clark Controller Co., Cleveland, Ohio
Zittel, T. O., asst. supt., Bethlehem Steel Co., Lackawanna Plant, Buffalo, N. Y.

74 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before August 21, 1948, or October 21, 1948, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Fellow

Coe, R. T., British Thomson-Houston Co. Ltd., Rugby, England
Pestarini, J. M., 128 Oxford Place, Staten Island, N. Y.

2 to grade of Fellow

To Grade of Member

Bhavanani, N., Dept. of Inspector General of Electricity, Hyderabad, India
Chang, S. S. L., Robbins & Myers Inc., Springfield, Ohio
Christie, S. L., McColpin-Christie Corp., Ltd., Los Angeles, Calif.
Clark, M. N., Pacific Gas & Elec. Co., Oakland, Calif.
Cook, M. B., Robert E. Hattis, Chicago, Ill.
Cornell, J. I., Solar Mfg. Corp., North Bergen, N. J.
Doremire, C., Dow Corning Corp., Midland, Mich.
Enright, C. J., N. Y. Tel. Co., New York, N. Y.
Formoso F., J., Mexican Light & Power Co., Ltd., Mexico, Federal District, Mexico
Henning, R. A., Boeing Aircraft Co., Seattle, Wash.
Holtzberg, A., Svenska AB Gasaccumulator, Lidingo, Sweden
Hornstein, I., The Technical Inst., Chamblee, Ga.
Kopecky, G. F., Delehanty Inst., New York, N. Y.
Larson, A. J., Public Service Co. of Northern Ill., Joliet, Ill.
Leak, B. W., Eastern Engg. Co., Cairo, Egypt
Lehnert, W. E., Audio Development Co., Minneapolis, Minn.
Loehr, H. T., Jr., International Mineral & Chemicals Corp., Mulberry, Fla.
MacDonald, C. J. (re-election) Bechtel Corp., St. Louis, Mo.
Markush, E. U., Eastern Mechanical Corp., New York, N. Y.
Martin Artajo, J. I., Instituto Catolico de Artes e Industrias, Madrid, Spain
Mauchly, J. W., Eckert-Mauchly Computer Corp., Philadelphia, Pa.
McIntyre, A. M., The Electric Controller & Mfg. Co., St. Louis, Mo.
Nicholson, G. C., Allied Chemical & Dye Corp., New York, N. Y.
Nicholson, R. A., Jr., City Public Service Board, San Antonio, Tex.
Peterson, R. A., Magnaflux Corp., Chicago, Ill.
Razor, C. T., The Citadel, Charleston, S. C.
Roberts, W. L., Westinghouse Research Labs, E. Pittsburgh, Pa.
Salin, J. P., Abo Akademi, Abo, Finland
Scott, H. S., General Elec. Co., Cleveland, Ohio
Smith, W. P., General Elec. Co., Schenectady, N. Y.
Steen, J. R., Sylvania Elec. Products Inc., Flushing, N. Y.
Sutton, M. E., Engineer Research & Devel. Labs., Ft. Belvoir, Va.
Waller, M., Capt., U.S.A.F., Howard Field, Canal Zone

33 to grade of Member

To Grade of Associate

United States, Canada, and Mexico

1. North Eastern

Beers, W. H., General Elec. Co., Schenectady, N. Y.
Dudley, L. A., Asplundh Tree Expert Co., Binghamton, N. Y.
Lindenfeld, J. A., General Elec. Co., Inc., Schenectady, N. Y.
Prashaw, E. C., Aluminum Co. of America, Massena, N. Y.
Rollins, W. B., Northeastern Engg. Inc., Manchester, N. H.
Schevtchuk, A., General Elec. Co., Schenectady, N. Y.
Scott, J. A. (re-election) Westinghouse Elec. Corp., Rochester, N. Y.

2. Middle Eastern

Baker, V. B., Westinghouse Elec. Corp., Pittsburgh, Pa.
Boggess, P. F., Westinghouse Elec. Corp., Lima, Ohio
Bryant, J. S., Naval Research Lab., Washington, D. C.
Canning, R. V., E. I. DuPont de Nemours & Co., Wilmington, Del.
Clotworthy, J. H., Westinghouse Elec. Corp., Baltimore, Md.
Darr, J. E., Pennsylvania State College, State College, Pa.
Ehrlinger, R. J., 231 Sieaforth Avenue, Pittsburgh, Pa.
Emrath, G. R., General Elec. Corp., Baltimore, Md.
Fedak, S., Army Security Agency, Washington, D. C.
Gordon, W. T., Westinghouse Elec. Corp., Lima, Ohio
Hildebrand, R. E., General Elec. Co., Philadelphia, Pa.
Knabe, C. F., General Elec. Co., Baltimore, Md.
Holloway, W. W., Chesapeake & Potomac Tel. Co. of Baltimore, Baltimore, Md.
Horelik, E. J., Jr., U. S. Rubber Co., Philadelphia, Pa.
Kirk, E. L., Republic Steel, Canton, Ohio
Loane, E. T., Chesapeake & Potomac Tel. Co. of Baltimore, Baltimore, Md.
MacArthur, H. E., Westinghouse Elec. Corp., Huntington, W. Va.
MacDonald, D. S., General Elec. Co., Baltimore, Md.
Marthinuss, G. L., Bethlehem Steel Co., Sparrows Point, Md.
McDaniel, E. N., Westinghouse Elec. Corp., Huntington, W. Va.
Northwood, L. L., Sr., I-T-E Circuit Breaker Co., Philadelphia, Pa.
Powell, J. N., General Elec. Co., Baltimore, Md.
Schultheis, W., General Elec. Co., Philadelphia, Pa.
Solomon, F. P., Pennsylvania Elec. Co., Johnstown, Pa.
Wheatley, F. E., Westinghouse Elec. Corp., Huntington, W. Va.
Yagerhofer, F. C., Naval Research Lab., Bellevue, D. C.
Young, M. L., The General Industries Co., Elyria, Ohio

3. New York City

Blauvelt, H. S., Public Service Elec. & Gas Co., Irvington, N. J.
Dowling, J. F., N. Y. Tel. Co., New York, N. Y.
Evans, F. E., N. Y. State Inst. of Applied Arts & Sciences, White Plains, N. Y.
Geisler, E. F., General Elec. Co., Newark, N. J.
Gold, J., Electric Boat Co., Bayonne, N. J.
Imm, J. J., General Elec. Co., Newark, N. J.
Patel, D. M., Polytechnic Inst. of Brooklyn, Brooklyn, N. Y.
Slurzberg, S., General Switch Corp., Brooklyn, N. Y.

4. Southern

Burdette, E. W., Oak Ridge National Lab., Oak Ridge, Tenn.
Colwes, J. A., Carbide & Carbon Chemicals Corp., Oak Ridge, Tenn.
Cone, M. S., The Wm. R. Moore School of Tech., Memphis, Tenn.
Glass, F. M., Oak Ridge Natl. Lab., Oak Ridge, Tenn.
Greer, L. P., Newberry Textile Mills, Newberry, S. C.
Landrum, T. W., Westinghouse Elec. Corp., Shreveport, La.
Owens, R. V., Jr., Southern Bell Tel. & Tel. Co., Jackson, Miss.
Palmer, O. H., Mississippi Power & Light Co., Jackson, Miss.
Sears, A., Appalachian Elec. Power Co., Roanoke, Va.
Williams, J. C., Interstate Fire & Burglar Alarms, Shreveport, La.
Woodall, H. C. (re-election), Carbide & Carbon Chemicals Corp., Oak Ridge, Tenn.

5. Great Lakes

Corey, C. C., Cutler-Hammer Inc., Milwaukee, Wis.
Donahue, J. H. (re-election), Sargent & Lundy, Chicago, Ill.
Goelz, G. W., Northwestern Univ., Evanston, Ill.
Henderson, W. L. R., General Elec. Co., Ft. Wayne, Ind.
Lescoe, J. D., Consumers Power Co., Essexville, Mich.
McSahne, F. R., Commonwealth Edison Co., Chicago, Ill.
Robbins, G. B., American Tel. & Tel. Co., Chicago, Ill.
Sherwood, W. L., Consumers Power Co., Jackson, Mich.
Stanley, E., Micro Switch, Freeport, Ill.
Winther, O. H., 900 Fauquier St., St. Paul, Minn.
Woolcott, C. P., Fairbanks, Morse & Co., Beloit, Wis

6. North Central

Achyutham, P., Univ. of Colorado, Boulder, Colo.
Clay, R. E., Intl. Engg. Co., Inc., Denver, Colo.
Lowe, J. W., Westinghouse Elec. Corp., Denver, Colo

7. South West

Arena, J. L., J. Fetto & Son, Elec. Co., St. Louis, Mo.
Chappell, G. G., Jr., J. M. Huber Corp., Borger, Tex.
Cristiani, A., Icontri. S. de R. L. Mexico, Federal District, Mexico
Garcia, A. F., Icontri. S. de R. L. Mexico, Federal District, Mexico
Harrell, D., Jr., Univ. of Texas, Austin, Tex.
Manero, J. L., Mexican Tel. & Tel. Co., Mexico, Federal District, Mexico
Parker, H. B., Black & Veatch, Engrs., Kansas City, Mo.
Patterson, R. (Miss), D. C. Pfeiffer, Dallas, Tex.
Paul, R. J. (re-election) Allis-Chalmers Mfg. Co., St. Louis, Mo.
Scheffler, H. (re-election) The Mexican Light & Power Co., Ltd., Mexico, Federal District, Mexico

8. Pacific

Archer, R. S., U. S. Army, San Francisco, Calif.
Bergstrom, R. O., C. F. Braun Co., Alhambra, Calif.
Black, W. F., Pacific Gas & Elec. Co., San Francisco, Calif.
Bruun, D. R., General Delivery, San Bernardino, Calif.
Decock, G. I., National Schools, Los Angeles, Calif.
Grossman, M. B., Sunbeam Lighting Co., Los Angeles, Calif.
Hillegass, C. A., J. M. Montgomery & Co. Inc., Los Angeles, Calif.
Jones, G. B., Lt., San Francisco Naval Shipyard, San Francisco, Calif.
Kaneko, G. S., County of Los Angeles, Los Angeles, Calif.
Kirk, W. E., Kirk-Palka Co., Los Angeles, Calif.
Lindheim, S., T. L. Rosenberg Co., Oakland, Calif.
Nelson, P. H., Von Bergen & Earl, San Francisco, Calif.
Ott, L. E., Western Precipitation Corp., Los Angeles, Calif.
Parsons, W. D., Southern California Edison Co., Los Angeles, Calif.
Prior, C. H., Jr., Dept. of Water & Power, Los Angeles, Calif.
Soengen, G. W. (re-election) Dept. of Water & Power, Los Angeles, Calif.
Tassan, C. R., Pacific Gas & Elec. Co., San Francisco, Calif.
Torell, C. C., Pacific Elec. Mfg. Corp., San Francisco, Calif.
York, E., Jr., California Inst. of Tech., Pasadena, Calif.

9. North West

Maeda, M., Bonneville Power Admin., Portland, Oreg.

10. Canada

Dover, C. F. B., The Steel Co. of Canada, Hamilton, Ontario, Canada
Raby, P. A., Hydro-Quebec, Montreal, Quebec, Canada

Elsewhere

Binder, G., Govt. Gold Mining Areas, Brakpan, South Africa
Chaudhri, D. P., E. S. D., Raipur (C. P.), India
Ciriello, C., Soc. Edison, Milan, Italy
Dastur, S. N. (Tata Iron & Steel Co. Ltd.), c/o Messrs. British Thomson Houston Co. Ltd., Rugby, England
Friedlander, E., General Elec. Co., Ltd., Witton, Birmingham, England
Gautama, R. K., U. P. Govt., Hydro Elec. Dept., Kanpur, India
Hinds, A. DeM., Tramway Light & Power Co. Ltd., Rio De Janeiro, Brazil, S. A.
Hore, R. A., The City & Guilds College, London, England
La Brooy, C. H. J., The Perak River Hydro Elec. Power Co. Ltd., Ipoh, Perak, Malaya
Neogi, B. C., Ordnance Factory, P. O. Ambernath, Bombay, India
Rajagopalan, K. S., The Swastik Oil Mills, Ltd., Bombay, India
Thakurdesai, G. K., Tata-Hydro, Bombay, India
Watzka, O. C. H., Watzka, & Sikola, Prague, Czechoslovakia

Total to grade of Associate

United States, Canada, and Mexico, 99
Elsewhere, 13

Officers and Committees for 1948–49

Officers

President

EVERETT S. LEE	Schenectady, N. Y.

(Term expires July 31, 1949)

Past Presidents

J. ELMER HOUSLEY	Alcoa, Tenn

(Term expires July 31, 1949)

B. D. HULL	Dallas, Tex.

(Term expires July 31, 1950)

Vice-Presidents

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4	J. H. BERRY	Norfolk, Va.
6	I. M. ELLESTAD	Omaha, Nebr.
8	D. I. CONE	San Francisco, Calif.
10	D. G. GEIGER	Toronto, Ontario, Canada

(Terms expire July 31, 1949)

1	VICTOR SIEGFRIED	Worcester, Mass.
3	J. L. CALLAHAN	New York, N. Y.
5	I. A. TERRY	Fort Wayne, Ind.
7	G. N. PINGREE	Dallas, Tex.
9	RICHARD McKAY	Spokane, Wash.

(Terms expire July 31, 1950)

Directors

J. M. FLANIGEN	Atlanta, Ga.
J. R. NORTH	Jackson, Mich.
WALTER C. SMITH	Palo Alto, Calif.

(Terms expire July 31, 1949)

J. F. FAIRMAN	New York, N. Y.
R. T. HENRY	Buffalo, N. Y.
E. P. YERKES	Philadelphia, Pa.

(Terms expire July 31, 1950)

W. L. EVERITT	Urbana, Ill.
A. C. MONTEITH	East Pittsburgh, Pa.
ELGIN B. ROBERTSON	Dallas, Tex.

(Terms expire July 31, 1951)

C. W. FICK	Cleveland, Ohio
M. D. HOOVEN	Newark, N. J.
F. O. McMILLAN	Corvallis, Oreg.

(Terms expire July 31, 1952)

Treasurer

W. I. SLICHTER	New York, N. Y.

(Term expires July 31, 1949)

Secretary

H. H. HENLINE	New York, N. Y.

(Term expires July 31, 1949)

Local Honorary Secretaries

AUSTRALIA—V. J. F. Brain, Electricity Authority of New South Wales, Box 2600 G.P.O., Sydney, New South Wales.
BRAZIL—Richard H. Bowles, Sao Paulo Tramway Light and Power Company, Caixa Postal 26-B, Sao Paulo.
ENGLAND—A. P. M. Fleming, Metropolitan Vickers Electric Company, Trafford Park, Manchester 17.
INDIA, NORTHERN—S. S. Kumar, Ellerslie, Simla-E, East Punjab.
INDIA, SOUTHERN—S. M. Zubair, Tata Bungalows, Kalyan.
NEW ZEALAND—R. D. Neale, School of Engineering, Cantebury University College, Christchurch C.1.
SWEDEN—Edy Velander, Box 5073, Stockholm 5.
TRANSVAAL—Francis E. Ingham, Box 6067, Johannesburg, Transvaal, South Africa.

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John L. Callahan
W. L. Everitt
R. T. Henry
B. D. Hull
A. C. Monteith
W. I. Slichter

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C.W. Franklin
W. N. Goodwin, Jr.
I. W. Gross
N. S. Hibshman
L. F. Hickernell
M. D. Hooven
L. C. Horle
I. F. Kinnard
C. R. Jones
A. E. Knowlton
C. M. Lafloon
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L. G. Pacent
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J. J. Pilliod
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S. S. Watkins
H. H. Weber
John Westbye
Sidney Withington

Constitution and Bylaws

Walter C. Smith, *chairman*, 680 Melville Avenue, Palo Alto, Calif.

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W. Scott Hill
Reginald L. Jones
W. W. Lewis
W. S. Peterson

Finance

E. P. Yerkes, *chairman*, Bell Telephone Company of Pennsylvania, 1835 Arch Street, Philadelphia, Pa.

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A. C. Monteith
Victor Siegfried

Headquarters

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H. H. Henline
H. H. Race
E. P. Yerkes

Members-for-Life Fund

C. R. Beardsley, *chairman*, Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.

T. F. Barton
N. E. Funk
A. H. Hull
E. H. Martindale
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W. I. Slichter
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Membership

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A. M. Spaulding
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District Vice-Chairmen

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F. H. Knapp (2)
Charles Clos (3)
Carl W. Evans (4)
H. M. Craig (5)
C. G. Rumohr (6)
E. W. Allen (7)
Charles R. Smith (8)
C. R. Kingsbury (9)
W. R. Way (10)

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Chairmen of membership committees of all Sections

Planning and Co-ordination

J. R. North, *chairman*, Commonwealth and Southern Corporation, Jackson, Mich.

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G. W. Bower
H. C. Coleman
J. F. Fairman
H. H. Henline
B. M. Jones
Reginald L. Jones
T. G. LeClair
J. J. Orr
H. S. Osborne
Elgin B. Robertson
Walter C. Smith
M. J. Steinberg
J. C. Strasbourger
J. D. Tebo
H. M. Turner
E. P. Yerkes

Publication

B. M. Jones, *chairman*, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.

J. M. Flanigen
P. B. Garrett
H. H. Henline
G. Ross Henninger
R. K. Honaman
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K. B. McEachron
J. J. Orr
B. R. Teare, Jr.
C. F. Wagner

Publicity, Institute

R. K. Honaman, *chairman*, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y.

Guy Bartlett
G. W. Bower
M. Getting
B. M. Jones
C. R. Jones
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H. M. Turner

Research

C. G. Suits, *chairman*, Research Laboratory, General Electric Company, Schenectady 5, N. Y.

B. G. Ballard
J. W. Barker
R. D. Bennett
L. V. Berkner
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C. R. Burrows
D. E. Chambers
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H. P. Corwith
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J. E. Hobson
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J. A. Hutcheson
M. J. Kelly
J. T. Littleton
A. D. Moore
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C. S. Schifreen
F. E. Terman
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Eric Walker
A. T. Waterman
V. K. Zworykin

Safety

Robin Beach, *chairman*, 32 Court Street, Brooklyn 2, N. Y.

M. M. Brandon
W. B. Buchanan
C. F. Dalziel
W. P. Dobson
L. P. Ferris
J. M. Flanigen
M. H. Hobbs
O. S. Hockaday
W. B. Kouwenhoven
J. O. Leslie
R. L. Lloyd
A. C. Muir
Albrecht Naeter
G. R. Radley
C. N. Rakestraw
W. T. Rogers
W. E. Rushlow
George Sangster
A. B. Smith
W. R. Smith
E. E. Turkington
H. H. Watson
H. B. Williams

Sections

J. C. Strasbourger, *chairman*, Cleveland Electric Illuminating Company, 75 Public Square, Cleveland 1, Ohio

D. I. Anzini
W. J. Barrett
F. S. Black
F. D. Bolton
G. W. Bower
S. C. Commander
H. A. Dambly
W. A. Dynes
O. R. Enriquez
C. W. Fick
H. W. Haberl
R. C. Horn
W. H. D. Horsfall
R. E. Kistler
C. P. Knost
C. W. Lethert
W. I. Middleton
L. R. Patterson
F. H. Pumphrey
C. S. Purnell
R. V. Shepherd
E. W. Stone

Ex-officio
Chairmen of Sections

Standards

Reginald L. Jones, *chairman*, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y.

Joseph Wm. Allen
R. W. Atkinson
E. L. Bailey
Sterling Beckwith
F. R. Benedict
R. C. Bergvall
M. M. Brandon
J. E. Clem
C. L. Dawes
W. P. Dobson
C. M. Gilt
John Grotzinger
F. E. Harrell
R. T. Henry
H. R. Huntley
H. E. Kent
A. C. Muir
J. R. North
J. E. O'Brien
M. S. Oldacre
G. H. O'Sullivan
F. B. Silsbee
R. C. Sogge

Ex-officio
Chairmen of working and co-ordinating committees of the Standards committee
Chairmen of AIEE technical committees
Chairmen of AIEE delegations on other standardizing bodies or sole representatives thereon
President, United States National Committee of the International Electrotechnical Commission

Technical Program

H. M. Turner, *chairman*, Yale University, New Haven, Conn.
F. A. Cowan
W. F. Henn
W. C. Kalb
A. J. Krupy
P. H. Light
F. O. McMillan
S. H. Mortensen
J. D. Tebo
Frank Thornton, Jr.

Ex-officio
Chairmen of:
- Technical co-ordinating committees
- Technical committees
- Committee on education
- Committee on planning and co-ordination
- Committee on research
- Committee on safety
- Standards committee

Transfers

F. W. Willcutt, *chairman*, Potomac Electric Power Company, 10th and E Streets, N.W., Washington 4, D. C.
F. A. Cooper
C. W. Fick
John Gammell
J. D. Harper
W. R. Hough
L. F. Hunt
J. W. Lingary
D. E. Moat
M. M. Moore
J. W. Robinson
H. B. Sargent
H. K. Smith
H. B. Wood

Ex-officio
Chairmen of transfers committees of all Sections

Professional Group Committees

Professional Group Co-ordinating Committee

T. G. LeClair, *chairman*, Commonwealth Edison Company, 72 West Adams Street, Chicago 90, Ill.
J. R. North
D. A. Quarles
Chairmen of professional group committees

Charles LeGeyt Fortescue Fellowship

H. E. Strang, *chairman* C. H. Willis
(*Terms expire July 31, 1949*)
H. N. Muller H. P. Sedwick
(*Terms expire July 31, 1950*)
J. W. Barker Roger I. Wilkinson
(*Terms expire July 31, 1951*)

Code of Principles of Professional Conduct

Harry Barker, *chairman*, Barker and Wheeler, 11 Park Place, New York 7, N. Y.
P. L. Alger
D. D. Ewing
E. S. Fields
E. H. Flath
Harold Goodwin, Jr.
D. C. Jackson
R. D. Maxson
R. W. Sorensen

Edison Medal

Appointed by the president for term of five years
O. E. Buckley A. E. Knowlton, *chairman* H. E. Strang
(*Terms expire July 31, 1949*)
C. V. Christie Zay Jeffries Harold Pender
(*Terms expire July 31, 1950*)
C. A. Corney S. M. Dean I. M. Stein
(*Terms expire July 31, 1951*)
Marvin W. Smith H. S. Osborne H. A. Winne
(*Terms expire July 31, 1952*)
D. I. Cone John B. MacNeill Philip Sporn
(*Terms expire July 31, 1953*)
Elected by the board of directors from its own membership for term of two years
W. L. Everitt J. F. Fairman A. C. Monteith
(*Terms expire July 31, 1949*)
(*Terms expire July 31, 1950*)

Ex-officio
Everett S. Lee, president
W. I. Slichter, treasurer
H. H. Henline, secretary

Education

B. R. Teare, Jr., *chairman*, Carnegie Institute of Technology, Pittsburgh, Pa.
H.W. Bibber
Donald S. Bridgman
W. L. Cassell
G. F. Corcoran
E. E. Dreese
W. L. Everitt
H. E. Hartig
T. N. Linville
E. A. Loew
A. H. Lovell
T. G. McFarland
H. N. Muller
J. A. Northcott, Jr.
R. C. Putnam
Claire W. Ricker
R. W. Sorensen
E. M. Strong
J. G. Tarboux
G. F. Tracy
C. E. Tucker
C. E. Tuites
E. A. Walker
R. W. Warner
S. Reid Warren

Lamme Medal

N. S. Hibshman, *chairman* T. G. LeClair A. C. Monteith
(*Terms expire July 31, 1949*)
F. E. Harrell D. A. Quarles J. B. Thomas
(*Terms expire July 31, 1950*)
J. H. Berry T. H. Morgan L. A. Umansky
(*Terms expire July 31, 1951*)

Management

W. L. Cisler, *chairman*, Detroit Edison Company, 2000 Second Avenue, Detroit 26, Mich.
P. L. Alger
K. P. Applegate
C. J. Beller
R. D. Bennett
H. K. Breckenridge
F. W. Bush
E. E. Hill
Lee H. Hill
A. C. Monteith
E. L. Moreland
H. A. Peterson
D. A. Quarles
F. M. Roberts
O. Van Rye

Prizes, Award of Institute

H. M. Turner, *chairman*, Yale University, New Haven, Conn.
H. C. Coleman
H. L. Davis, Jr.
B. M. Jones
W. C. Kalb
T. G. LeClair
H. N. Muller
J. J. Orr
J. J. Pilliod
F. M. Sebast
M. J. Steinberg
J. C. Strasbourger
C. G. Suits
J. D. Tebo

Registration of Engineers

J. E. Hobson, *chairman*, Stanford Research Institute, Stanford University, Stanford, Calif.
E. H. Bancker
L. O. Campbell
J. H. Foote
N. L. Freeman
L. A. Griffith
J. D. Guillemette
F. W. L. Hill
Harry B. Joyce
R. E. Kistler
K. B. McEachron
R. E. Muehlig
J. G. Patterson
W. W. Perry
Elgin B. Robertson
L. M. Robertson

Student Branches

H. N. Muller, *chairman*, Westinghouse Electric Corporation, East Pittsburgh, Pa.
Sterling Beckwith
J. F. Calvert
P. L. Hoover
J. H. Kuhlmann
J. D. McCrumm
F. O. McMillan
W. H. Pickering
R. G. Porter
L. T. Rader
E. M. Strong
R. W. Warner
B. S. Willis

Ex-officio
Student Branch counselors

Technical Committees

Power Group

Power Co-ordinating Committee

M. J. Steinberg, *chairman*, Consolidated Edison Company of New York, Inc., 4 Irving Place, New York, N. Y.
H. W. Collins
R. T. Henry
A. J. Krupy
W. J. McLaghlan
Frank Thornton, Jr.

Ex-officio
Chairmen of the 12 following technical committees in the power group

Carrier Current

L. F. Kennedy, *chairman*, General Electric Company, central station engineering divisions, 1 River Road, Schenectady 5, N. Y
S. C. Bartlett
W. H. Blankmeyer
C. W. Boadway
J. M. Dunham
L. G. Eaton
R. C. Ericson
L. F. Ferri
W. J. Googe
E. W. Kenefake
S. C. Leyland
S. Lubin
L. E. Ludekens
D. M. MacGregor
T. W. MacLean
R. H. Miller
R. E. Neidig
Merle Robison
Trueman T. Smith
Oliver A. Starcke
T. D. Talmage
Mead Warren, Jr.

CARRIER CURRENT SUBCOMMITTEES

1. Project—Preparation of a General Interest Paper on Carrier Current

Scope: This paper is to give a historical review of the carrier developments and outline the place the carrier has in present-day system operating practices.

J. D. Booth, *chairman*
S. C. Bartlett
L. F. Kennedy

2. Project Committee Report on Application Guidance for Carrier Current

D. M. MacGregor, *chairman*
C. W. Boadway
T. D. Talmage

3. Working Group to Prepare Suggested Methods of Measurement

Scope: Establishment of methods of measurements in the carrier field.

E. W. Kenefake, *chairman*
S. C. Bartlett
C. W. Boadway
M. H. Wood

4. Working Group on High-Frequency Characteristics of Power Equipment

S. C. Leyland, *chairman*
T. A. Cramer

5. Working Group for Data on Carrier-Current Characteristics of Transmission Lines and Systems

Scope: Power system measurements at carrier frequency dealing primarily with transmission lines and substations.

R. C. Erickson, *chairman*
W. H. Blankmeyer
W. J. Googe
L. E. Ludekens
T. D. Talmage

6. Working Group on Standard Terminology for Carrier Current

S. C. Leyland, *chairman*

7. Working Group on Coupling Capacitors and Traps for Rural Line Carrier Telephone

S. C. Bartlett, *chairman*

8. Working Group on Use of Microwave Equipment for Relaying Telemetering and Supervisory Control

S. C. Leyland, *chairman*

9. Working Group on Operating Experience with Carrier Current Relaying Channels

O. A. Starcke, *chairman*

Electronic Power Converter

H. Winograd, *chairman*, Allis-Chalmers Manufacturing Company, electrical department, Milwaukee 1, Wis.
H. R. Blomquist
W. F. Bonner
J. L. Boyer
J. H. Cox
F. W. Cramer
J. B. Donnelly
Wm. Fraser
W. E. Gutzwiller
P. L. Hartsock
C. C. Herskind
H. E. Houck
G. N. Hughes
Otto Jensen
C. R. Marcum
D. E. Marshall
A. J. Maslin
L. W. Morton
R. A. Nelson
M. E. Reagan
W. J. L. Rupprecht
A. Schmidt, Jr.
W. C. Sealey
S. L. Smith
H. C. Steiner
O. J. Swanson
T. A. Taylor
J. T. Thwaites
Joel Tompkins
C. H. Willis

ELECTRONIC POWER CONVERTER SUBCOMMITTEES

1. Policy and Planning Subcommittee

Scope: The function of this subcommittee is to plan and co-ordinate the activities of the main committee and its subcommittees. It will consist of the officers and the preceding chairman of the main committee, the chairmen of the subcommittees, and any other committee members designated by the chairman.

Main Committee Officers:
H. Winograd, *chairman*
C. C. Herskind, *vice-chairman*
H. C. Steiner, *secretary*
C. H. Willis, *preceding chairman*
Subcommittee Chairmen:
C. R. Marcum
D. E. Marshall
A. J. Maslin
L. W. Morton
Joel Tompkins

2. Electronic Converter Application Subcommittee

Scope: This subcommittee will handle matters relating to the application and operation of electronic power converters, such as rating, installation, operation, maintenance, inductive co-ordination.

L. W. Morton, *chairman*
Joel Tompkins, *cochairman*
F. W. Cramer
J. B. Donnelly
Wm. Fraser
N. W. Geist
W. E. Gutzwiller
H. E. Houck
W. J. L. Rupprecht
S. L. Smith
O. J. Swanson
T. A. Taylor
J. T. Thwaites

3. Electronic Converter Circuits Subcommittee

Scope: This subcommittee will handle matters relating to circuit theory, protection, and control of electronic power converters. It will co-operate with the other subcommittees and with other AIEE committees (such as electronics, switchgear, protective devices substations) on matters of mutual interest.

C. C. Herskind, *chairman*
W. F. Bonner
J. L. Boyer
I. K. Dortort
G. N. Hughes
G. F. Jones
R. A. Nelson
M. E. Reagan
A. Schmidt, Jr.
T. A. Taylor
C. H. Willis
H. Winograd

4. Papers and Speakers Subcommittee

Scope: This subcommittee will complete the bibliography on electronic power converters and will keep it up to date with annual supplements. It will make recommendations on subjects for technical papers and promote the preparation of such papers. It will prepare information on the availability of speakers and educational material on electronic power converters, as an aid to schools, AIEE Sections, and discussion groups.

C. R. Marcum, *chairman*
J. B. Rice
J. T. Thwaites
H. E. Zuverg

5. Rectifier Transformers Subcommittee

Scope: This subcommittee will handle matters relating to transformer equipment used for electronic power converters. It will maintain liaison with the AIEE transformer committee, to keep the two committees informed on matters of mutual interest.

A. J. Maslin, *chairman*
E. V. DeBlieux
W. C. Sealey

6. Rectifying Devices Subcommittee

Scope: This subcommittee will handle matters relating to design and characteristics of rectifying devices used for electronic power converters. It will maintain liaison and co-operate with other technical committees of the AIEE and other organizations which carry on activities relating to such rectifying devices, and it will keep the electronic power converter committee informed on such activities.

D. E. Marshall, *chairman*

7. West-Coast Subcommittee

J. H. Cox, *chairman*

8. Other Projects from Last Year

(*a*). Preparation of report on protection of electronic power converters. By electronic converter circuits subcommittee; C. C. Herskind, chairman of working group.

(*b*). Bibliography on electronic power converters. By papers and speakers subcommittee; C. R. Marcum, chairman of working group.

(*c*). 1. Prepare forms for collecting application, operating, and maintenance data on mercury-arc power converters.

2. Collect data on a-c system characteristics and load characteristics in rectifier installations for various industries.

3. Power metering in rectifier installations. By electronic converter application subcommittee; L. W. Morton, chairman.

(*d*). Prepare report on inductive co-ordination relating to d-c side of rectifier installations. By electronic converter application subcommittee; T. A. Taylor, chairman of working group.

Insulated Conductor

L. F. Hickernell, *chairman*, Anaconda Wire and Cable Company, Hastings-on-Hudson 6, N. Y.

G. W. Acock
C. F. Avila
H. G. Barnett
C. E. Baugh
A. Bodicky
A. S. Brookes
T. J. Brosnan
W. R. Bullard
H. W. Clark
M. T. Crawford
Alan S. Dana
E. W. Davis
W. A. Del Mar
C. D. Eash
D. M. Farnham
G. H. Fiedler
L. E. Fogg
J. H. Foote
M. W. Ghen
H. Halperin
C. T. Hatcher
T. G. Hieronymus
R. A. Hopkins
Glen T. Koger
L. I. Komives
M. J. Lowenberg
C. G. Mansfield
R. E. Morse
E. F. Nuezel
W. T. Peirce
R. S. Peterson
A. D. Pettee
H. S. Phelps
R. A. Schatzel
G. B. Shanklin
V. A. Sheals
H. D. Short
F. V. Smith
L. G. Smith
E. G. Sturdevant
Gordon Thompson
C. W. White
R. J. Wiseman
K. S. Wyatt
C. W. Zimmerer

INSULATED CONDUCTOR SUBCOMMITTEE

1. Administration Subcommittee

Scope: The activities of this subcommittee include subcommittee organization and scopes, co-ordination of subcommittee activities, program planning, and selection of papers for national meetings.

Main Committee Officers:
L. F. Hickernell, *chairman*
H. Halperin, *vice-chairman*
C. T. Hatcher, *secretary*
R. J. Wiseman

Subcommittee Chairmen:
A. S. Brookes
W. A. Del Mar
G. H. Fiedler
J. H. Foote
M. W. Ghen
G. T. Koger
L. I. Komives
W. T. Peirce
R. S. Peterson
G. M. L. Sommerman
Gordon Thompson

2. Standards and Publications Subcommittee

A. S. Brookes, *chairman*
A. P. S. Bellis
L. E. Fogg
J. H. Foote
V. A. Sheals
C. W. Zimmerer

Projects:
(*2-1*). Standard number 30 (1944)—revision
(*2-2*). Insulated Conductor Reference Book

3. Cable Characteristics Subcommittee

W. A. Del Mar, *chairman*
H. Halperin
C. T. Hatcher
C. G. Mansfield
R. J. Wiseman
M. H. McGrath
J. H. Neher
G. B. Shanklin
F. V. Smith

Projects:
(*3-1*). Current-carrying capacity of buried cables
(*3-2*). Zero-sequence impedance of cables
(*3-3*). A-c resistance of cables in conduit (paper)
(*3-4*). Reactance of cables in conduit (paper)
(*3-5*). Use of reduced-scale models for the solution of cable problems
(*3-6*). Hydraulic aspect of oil-filled pipe cables
(*3-7*). Movement of buried cable

4. Conductors Subcommittee

J. H. Foote, *chairman*

Projects:
(*4-1*). Determination of conductor resistivity
(*4-2*). Definition of terms relating to conductors
(*4-3*). *NBS* circular number 31—revision

5. Insulations Subcommittee

G. M. L. Sommerman, *chairman*
J. C. Balsbaugh
C. E. Betzer
F. M. Clark
A. S. Dana
E. W. Greenfield
J. D. Piper
R. A. Schatzel
A. J. Warner
K. S. Wyatt

Projects:
(*5-1*). Properties of synthetic rubber and plastics

6. Sheaths and Coverings Subcommittee

G. H. Fiedler, *chairman*
C. E. Betzer
A. S. Brookes
F. E. Kulman
A. D. Pettee
H. S. Phelps
V. A. Sheals
G. W. Zink

Projects:
(*6-1*). Properties of lead and lead alloy sheathing
(*6-2*). Properties of nonmetallic sheaths
(*6-3*). Protective covering for lead sheathing
(*6-4*). Evaluation of simulated service tests on lead sheathing

7. Cable Supply Systems Subcommittee

L. I. Komives, *chairman*
C. F. Avila
H. G. Barnett
T. J. Brosnan
W. R. Bullard
H. W. Clark
D. M. Farnham
H. Halperin
C. T. Hatcher
A. D. Pettee
C. S. Schifreen
G. B. Shanklin
H. D. Short
C. W. White
R. J. Wiseman
K. S. Wyatt

Projects:
(*7-3*). 69-kv cable installations at Philadelphia (paper)
(*7-5*). 69-kv cable installation at Milwaukee (paper)
(*7-6*). Nonmetallic sheathed cable in ducts for primary distribution
(*7-7*). Nonmetallic sheathed cable in ducts for secondary distribution
(*7-8*). Buried cable for distribution systems
(*7-9*). Aerial cable for distribution systems
(*7-10*). 69-kv medium-pressure gas-filled cable installation at Washington, D. C.
(*7-11*). Low-pressure gas-filled cable installations
(*7-12*). Paper cable with reduced insulation, short lays, soft binders, and so forth
(*7-13*). Economics of various types of extra-high-voltage cable systems
(*7-14*). Low versus high-viscosity oil for gas-pressure cable

8. Utilization Wiring Systems Subcommittee

G. T. Koger, *chairman*
E. L. Bailey
H. G. Barnett
Allen Coggeshall
C. A. Finkel
M. G. Houghton
M. J. Lowenberg
J. B. MacLean
L. C. Peterman
Kennard Pinder
S. J. Rosch
R. A. Schatzel
E. G. Sturdevant
C. V. Waddington
C. W. Zimmerer
G. W. Zink

Projects:
(*8-1*). National Electric Code—Problems affecting its application
(*8-2*). Wiring systems for corrosive and hazardous locations
(*8-3*). Metallic versus nonmetallic wiring
(*8-4*). Insulated aluminum conductors for utilization voltages
(*8-5*). The case for the bare neutral
(*8-6*). Conduit as a return conductor

9. Special Purpose Cables Subcommittee

W. T. Peirce, *chairman*
G. W. Acock
J. F. Atkinson
M. T. Crawford
E. W. Davis
S. F. French
Myron Zucker
R. A. Hopkins
G. H. Landis
M. J. Lowenberg
H. S. Moore
F. V. Smith
W. N. Zippler

Projects:
(*9-1*). Standard number 45—sections 18, 19, 20 (1945)—revision
(*9-2*). American versus foreign shipboard cable practice
(*9-3*). Mining cable
(*9-4*). Vertical-riser cable
(*9-5*). Generator lead cable

10. Accessories Subcommittee

M. W. Ghen, *chairman*
C. Christianson
C. D Eash
T. G. Hieronymus
J. E. Johnson
L. Wetherill
H. E. Martin
R. E. Morse
J. H. Nicholas
E. F. Nuezel
F. P. West

Projects:
(*10-1*). Standard number 48 on cable potheads (1948)—discussion
(*10-2*). Termination of nonmetallic sheathed cables
(*10-3*). Development and technique of soldered porcelain potheads
(*10-4*). Interchangeability of potheads
(*10-5*). Molded joints for polyethylene-insulated coaxial cable
(*10-6*). Standard on cable limiters
(*10-7*). Effect of external bushing contamination on flashover value of potheads
(*10-8*). Fundamental design characteristics of potheads
(*10-9*). Aerial-cable accessories

11. Structures Subcommittee

R. S. Peterson, *chairman*
C. E. Baugh
Andrew Bodicky
T. J. Brosnan
H. W. Clark
H. L. Davis, Jr.
C. D. Eash
G. H. Fiedler
M. W. Ghen
C. G. Mansfield
L. G. Smith
F. P. West

Projects:
(*11-1*). Conduits
(*11-2*). Gases in underground structures
(*11-3*). Transformer manhole and vault design and ventilation
(*11-4*). Manhole construction
(*11-5*). Supports for aerial cable
(*11-6*). Supports for bridge cable
(*11-7*). Under river crossings
(*11-8*). Submarine cables and methods of support
(*11-9*). Cable installations in tunnels

12. Tests and Measurements Subcommittee

Gordon Thompson, *chairman*
J. C. Balsbaugh
A. L. Brownlee
R. W. Chadbourn
A. S. Dana
E. W. Davis
W. A. Del Mar
E. W. Greenfield
E. S. Halfmann
F. K. Harris
J. C. Parker
H. D. Short
G. M. L. Sommerman
E. R. Thomas
R. J. Wiseman
C. W. Zimmerer

Projects:
(*12-1*). Test code for insulated conductors
(*12-2*). Equivalent 1-hour life for oil-filled and gas-filled cable
(*12-3*). High-frequency measurements
(*12-4*). A-c resistance and reactance measurements
(*12-5*). Impulse strength testing
(*12-6*). Practice in testing of installed cables
(*12-7*). Determination of tensile strength of lead sheathing

Power Generation

A. H. Frampton, *chairman*, Hydro-Electric Power Commission of Ontario, electrical engineering department, Toronto 2, Ontario, Canada.

H. A. Adler
R. E. Appleyard
J. E. Barkle
S. Beckwith
J. A. Brooks
G. Calabrese
A. D. Caskey
S. M. Denton
E. F. Dissmeyer
Alex. Dovjikov
J. M. Drabelle
J. Finlaw
C. B. Fontaine
C. A. Harrington
H. R. Harris
A. P. Hayward
B.V. Hoard
E. L. Hough
W. R. Johnson
L. A. Kilgore
A. J. Krupy
F. L. Lawton
W. J. Lyman
J. T. Madill
A. P. Maness
T. H. Mawson
J. B. McClure
G. H. McDaniel
D. R. Pattison
W. S. Peterson
A. L. Pollard
F. L. Reinmann
B. G. A. Skrotzki
G. M. Tatum
C. W. Watchorn
G. R. Woodman

POWER GENERATION SUBCOMMITTEES

1. Prime Movers Subcommittee

Scope: To study, review design, installation practices, and other features of all types of prime movers and their associated equipment (except hydraulic units) as related to electric power generation. To sponsor specifications, Standards, and technical sessions, the latter to be devoted principally to new developments or review of existing practices. To co-operate with other committees of organizations such as American Society of Mechanical Engineers and Edison Electric Institute.

2. Speed Governing Subcommittee

Scope: To study, review design, installation practices, and other features of all types of prime-mover governing systems, including hydroelectric. To sponsor specifications, Standards, and technical sessions and cooperate with other committees of the AIEE and other societies.

3. Excitation Systems Subcommittee

Scope: Similar functions as for the speed-governing subcommittee in the field of generating-station excitation systems.

4. Station Design Subcommittee

Scope: To review designs and installation practices in electric generating stations considered as a unit. To sponsor technical sessions covering new or improved practices. To analyze trends and designs and present general interest material of future possibilities. This subcommittee will not cover hydroelectric stations.

5. Hydroelectric Systems Subcommittee

Scope: Combining the scope, for hydroelectric station only, of the prime movers and station design subcommittees.

6. Pacific Coast Subcommittee

Scope: To foster closer co-operation with the western members in all projects undertaken by the main committee. To provide direct contact in the planning of Pacific Coast technical meetings.

Protective Devices

G. B. Dodds, *chairman*, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh 19, Pa.

V. J. Cissna
J. E. Clem
L. M. Connors
H. A. Cornelius
F. M. Defandorf
R. H. Earle
W. W. Eberhardt
G. W. Gerell
E. M. Hunter
P. A. Jeanne
Alva A. Johnson
J. H. Kinghorn
E. W. Knapp
W. E. Knouse
W. A. Lewis, Jr.
F. R. Longley
C. Lowerison
T. H. Mawson
J. R. McFarlin
C. McLean
E. G. Norrell
A. M. Opsahl
W. J. Rudge
W. E. Rushlow
O. L. Sidenfaden
W. T. Smith
H. R. Stewart
J. M. Towner
S. S. Watkins
E. H. Yonkers

PROTECTIVE DEVICES SUBCOMMITTEES

1. Lightning Protective Devices Subcommittee

H. R. Stewart, *chairman*
E. H. Yonkers, *secretary*
H. A. Cornelius
F. M. Defandorf
R. H. Earle
Milan Getting
I. W. Gross
E. H. Grosser
H. W. Hartzell
T. W. Mawson
J. R. McFarlin
W. A. McMorris
A. M. Opsahl
W. E. Rushlow
A. H. Schirmer
J. M. Towner
E. R. Whitehead

Project 1: Application guide of methods for lightning protection of substations.
H. A. Cornelius, *chairman*
E. H. Grosser
H. W. Hartzell
S. B. Howard
E. L. Jarrett
R. H. Mertz
A. M. Opsahl

Project 4: Lightning protection for unit substations.
E. R. Whitehead, *chairman*
H. W. Hartzell
E. M. Hunter
A. A. Johnson
J. M. Towner

Project 5: Revise and combine AIEE Standards 24, 28 and 47.
F. M. Defandorf, *chairman*
R. H. Earle
I. W. Gross
E. H. Grosser
J. R. McFarlin
W. A. McMorris
A. M. Opsahl
W. E. Rushlow
A. H. Schirmer
J. M. Towner
E. H. Yonkers

Project 6: Performance characteristics of station type arresters.
W. A. McMorris, *chairman*

Project 7: Performance characteristics of valve type distribution arresters.
J. R. McFarlin, *chairman*
R. H. Earle
T. I. Eldridge
W. A. McMorris
A. M. Opsahl

Project 8: Performance characteristics of 20 to 73 kv line type arresters.
R. H. Earle, *chairman*

Project 9: Joint working group (with general systems subcommittee of transmission and distribution committee) on recovery voltage characteristics of distribution systems.
R. L. Witzke, *chairman*
I. B. Johnson
L. M. Olmstead
M. A. Polster
W. E. Rushlow

Project 10: Performance characteristics of line expulsion arresters.
A. M. Opsahl, *chairman*

Project 11: Combined performance characteristics of lightning protective devices.
E. H Grosser, *chairman*
R. H. Earle
J. R. McFarlin
Milan Getting
W. A. McMorris
A. M. Opsahl

Project 12: Status of rod gap characteristics.
Milan Getting, *chairman*

2. Fault Limiting Devices Subcommittee

A. A. Johnson, *chairman*
J. E. Clem
W. W. Eberhardt
E. T. B. Gross
H. W. Hartzell
E. M. Hunter
P. A. Jeanne
E. W. Knapp
W. A. Lewis
F. R. Longley
W. E. Marter
E. G. Norell
O. L. Sidenfaden
W. T. Smith

Project 1: Application guide on methods of grounding transmission systems.
E. M. Hunter, *chairman*
H. W. Hartzell
A. A. Johnson
R. E. Neidig

Project 2: Application guide on methods of grounding generator systems.
A. A. Johnson, *chairman*
E. M. Hunter
D. M. MacGregor
W. E. Marter
E. G. Norell
W. T. Smith

Project 3: Bibliography of literature on grounding devices.
E. T. B. Gross, *chairman* P. A. Jeanne W. A. Lewis

Project 4: Field survey of and application problems associated with ground fault neutralizers.
J. E. Clem, *chairman*
H. H. Brown
B. H. Clingerman
S. S. Cook
N. E. Dillon
W. D. Hardaway
R. E. Neidig

Project 5: Power system fault limitation.
F. R. Longley
J. O. R. Coleman
F. H. Kierstead
L. B. LeVesconte
H. F. Lindemuth
E. L. Michelson
L. E. Sauer

Relay

W. R. Brownlee, *chairman*, The Commonwealth and Southern Corporation, Jackson, Mich.

R. J. Cooper
R. E. Cordray
G. E. Dana
G. B. Dodds
F. S. Fehr
L. F. Ferri
L. L. Fountain
S. Goldsmith
E. T. B. Gross
W. A. Lewis, Jr.
S. C. Leyland
H. F. Lindemuth
J. R. Linders
C. Lowerison
W. E. Marter
A. J. McConnell
E. L. Michelson
W. A. Morgan
C. E. Parks
T. R. Halman
E. L. Harder
V. J. Hayes
B. C. Hicks
J. H. Kinghorn
R. A. Larner
H. R. Paxson
F. C. Poage
E. G. Ratz
K. N. Reardon
W. K. Sonnemann
G. S. Steeb
E. C. Wentz

RELAY SUBCOMMITTEES

1. Project Committee on Bibliography of Relay Literature

E. T. B. Gross, *chairman*
S. Goldsmith
C. E. Parks
C. L. Smith

2. Project Committee on Generator Protection

H. R. Paxson, *chairman*
L. L. Draper
B. C. Hicks
S. C. Leyland
H. F. Lindemuth
W. E. Marter
J. B. McClure
A. J. McConnell
C. E. Parks
F. C. Poage
C. L. Smith

3. Project Committee on Co-ordination of Construction and Protection of Distribution Circuits (Joint with Distribution Subcommittee and Edison Electric Institute)

G. B. Dodds, *AIEE sponsor* C. J. Beller, *EEI sponsor*

Relay Committee Appointees:	*Distribution Subcommittee Appointees:*	*EEI*
H. W. Haberl	R. O. Askey	G. H. Fiedler
C. L. Headley	T. J. Brosnan	W. McLean
C. Lowerison	W. B. Fisk	E. W. Knapp
C. E. Parks	A. L. Malmstrom	
H. P. Sleeper	H. F. Ostman	
C. L. Smith	J. S. Parsons	
	R. F. Quinn	

4. Project Committee on Revision of Standards for Power Relays

S. C. Leyland, *chairman*
R. E. Cordray
V. L. Cox
L. L. Fountain
W. A. Lewis
E. L. Michelson

5. Project Committee on Sensitive Ground Protection

E. T. B. Gross, *chairman*
C. J. Berghs
R. J. Cooper
T. R. Halman
P. A. Jeanne
C. Lowerison
W. K. Sonnemann
A. R. van C. Warrington

6. Project Committee on Transmission Line Protection

E. L. Harder, *chairman*
L. J. Audlin
W. R. Brownlee
B. C. Hicks
J. H. Kinghorn
W. A. Lewis
W. E. Marter
A. J. McConnell
M. S. Merritt
E. L. Michelson
C. E. Parks
K. N. Reardon

7. Project Committee on Electronic Relay Applications

A. J. McConnell, *chairman*
J. E. Barkle
R. J. Cooper
F. S. Fehr
E. L. Harder
J. H. Kinghorn
D. M. McGregor
E. L. Michelson
E. G. Ratz

8. Project Committee on Insulation Levels of Relay and Control Circuit

E. L. Michelson, *chairman*
R. E. Cordray
S. Goldsmith
T. R. Halman
V. J. Hayes
W. K. Sonnemann

9. Project Committee on Relaying of Interconnections Between Industrial and Utility Generating Systems

K. N. Reardon, *chairman*
J. E. Barkle
G. E. Dana
F. S. Fehr
T. R. Halman
J. R. Linders

10. Projection Committee on Relay Protection for Stations Without High-Voltage Switching

E. L. Michelson, *chairman*
L. F. Ferri
L. L. Fountain
V. J. Hayes
R. A. Larner
K. N. Reardon

11. Proposed Future Projects:

(*a*). Capacitance potential device transient performance as influencing relay operation.

(*b*). Review of bus protection methods and performance.

(*c*). Relay protection of circuits following sustained interruptions.

(*d*). A-c and low-voltage d-c tripping methods (joint).

(*e*). Relay test methods.

(*f*). Switching schemes influencing relay protection.

(*g*). Ultrahigh-frequency radio protective relay applications.

(*h*). Design and protection of pilot-wire channels.

(*i*). Uniform records of relay performance.

Rotating Machinery

C E. Kilbourne, *chairman*, General Electric Company, turbine divisions, 1 River Road, Schenectady 5, N. Y.

J. E. Allen
G. R. Anderson
W. R. Appleman
E. L. Bailey
S. Beckwith
A. G. Conrad
J. DeKiep
L. O. Dorfman
E. E. Dreese
J. L. Fuller
J. S. Gault
C. B. Hathaway
V. P. Hessler
L. E. Hildebrand
T. A. Hopkins
W. R. Hough
J. W. Jones
M. P. Kent
C. Kingsley, Jr.
A. A. Kroneberg
T. M. Linville
T. C. Lloyd
M. R. Lory
C. Lynn
G. W. McIver, Jr.
R. C. Moore
J. G. Noest
E. I. Pollard
C. P. Potter
F. C. Rushing
M. L. Schmidt
J. F. Sellers
H. R. Sills
T. W. Trice
P. H. Trickey
C. G. Veinott
R. W. Wieseman
J. C. Woods

ROTATING MACHINERY SUBCOMMITTEES

1. Administrative Subcommittee

C. E. Kilbourne, *chairman*
W. R. Hough
T. M. Linville
J. L. Fuller
E. I. Pollard
F. C. Rushing
M. L. Schmidt
R. W. Wieseman

2. Synchronous Machinery Subcommittee

E. I. Pollard, *chairman*
Sterling Beckwith
J. F. Calvert
S. B. Crary
J. DeKiep
L. O. Dorfman
A. M. Goodison, Jr.
E. L. Harder
R. A. Hopkins
L. F. Hunt
J. W. Jones
C. E. Kilbourne
G. W. McIver
W. P. Monroe
J. G. Noest

3. Induction Machinery Subcommittee

F. C. Rushing, *chairman*
E. L. Bailey
E. C. Barnes
B. M. Cain
S. F. Henderson
Charles Kingsley, Jr.
C. J. Koch
T. C. Lloyd
R. C. Moore
J. G. Noest
C. P. Potter
P. H. Trickey

4. D-C Machinery Subcommittee

T. M. Linville, *chairman*
W. E. Clancy
F. A. Compton
Lanier Greer
L. N. Grier
J. L. Hamilton
C. B. Hathaway
V. P. Hessler
P. Lebenbaum
C. Lynn
D. Ramadanoff
J. F. Sellers

5. Single-Phase and Fractional-Horsepower Subcommittee

M. L. Schmidt, *chairman*
W. R. Appleman
I. M. Cain
B. M. Levy
R F. Muncie
P. H. Trickey
C. G. Veinott
N. S. Yost

6. Test Code Subcommittee

J. L. Fuller, *chairman*
T. E. M. Carville
T. C. Lloyd

7. Insulation Resistance Subcommittee

R. W. Wieseman, *chairman*
H. R. Stewart, *secretary*
J. E. Allen
L. J. Berberich
E. B. Curdts
E. F. Dissmeyer
Orville E. Fawcett
D. D. Higgins
J. W. Jones
F. M. Porter
V. E. Schlossber
J. B. Swering
A. L. Van Emden
C. O. Weilbaeche

Substations

G. S. Lunge, *chairman*, General Electric Company, central station engineering divisions, 1 River Road, Schenectady 5, N. Y.

H. Bany
H. Barber
R. O. Bell
F. J. Berger
M. K. Brown
M. V. Eardley
R. C. Ericson
G. P. Fallon
J. M. Flanigen
M. Fraresso
S. F. French
H. F. Gidlund
C. D. Highleyman
W. L. Hiscox
K. B. Hoffman
E. M. Hunter
S. C. Killian
I. F. Krughoff
W. J. Lank
N. G. Larson
J. T. Lienert
W. M. McCauley
M. E. Reagan
S. L. Smith
K. L. Wheeler
G. S. Whitlow

SUBSTATION SUBCOMMITTEES

1. Executive Subcommittee

Scope: To plan and co-ordinate the activities of the main committee and its subcommittees including consideration of their scopes, program planning, and assistance in selection of papers.

Main Committee Officers:
G. S. Lunge, *chairman*
R. C. Ericson, *vice-chairman*
M. Fraresso, *secretary*

(*Subcommittee chairmen and personnel to be selected.*)

2. Transmission Substation Subcommittee

Scope: Responsible for treatment of all problems of structural and electrical design, construction and arrangement of these substations known as transmission substations.

(*Subcommittee chairmen and personnel to be selected.*)

3. Distribution and Conversion Substation Subcommittee

Scope: Responsible for treatment of all problems of structural and electrical design, construction and arrangement of those substations known as distribution substations.

(*Subcommittee chairmen and personnel to be selected.*)

4. Automatic and Supervisory Control Subcommittee

Scope: Responsible for treatment of all problems relating to the development of automatic, remote, and manual control, and also fundamental electrical diagrams pertaining to substations.

(*Subcommittee chairmen and personnel to be selected.*)

Switchgear

F. A. Lane, *chairman*, American Gas and Electric Service Corporation, 30 Church Street, New York 7, N. Y.

C. K. Beyette
C. H. Black
Harry Brown
I. S. Brown
E. A. Childerhose
H. W. Codding
F. W. Cramer
G. H. Doan
W. E. Enns
K. J. C. Falck
R. M. Ferrill
J. M. Geiger
W. J. Gilson
W. D. Hardaway
V. J. Hayes
M. H. Hobbs
L. M. Hovey
C. L. Killgore
H. A. P. Langstaff
H. J. Lingal
W. J. McLachlan
R. G. Meyerand
E. F. Miller
J. R. North
H. V. Nye
M. W. Rothpletz
H. H. Rudd
O. L. Sidenfaden
F. V. Smith
G. Stamper
A. Van Ryan
J. H. Vivian
R. L. Webb
C. E. Winegartner
J. D. Wood
J. C. Woods
D. G. Worth
S. W. Zimmerman

SWITCHGEAR SUBCOMMITTEES

1. Circuit Breaker Subcommittee

C. H. Black, *chairman*
F. W. Cramer
R. M. Ferrill
E. Hardaway
M. H. Hobbs
W. J. McLachlan
J. R. North
H. V. Nye
F. V. Smith
J. H. Vivian
R. L. Webb
K. L. Wheeler
J. D. Wood
J. C. Woods

The following working groups have been set up within this subcommittee:

A—Power circuit breakers.
B—Low-voltage air circuit breakers.
C—Automatic reclosers.
D—Calculations of short-circuit currents in low-voltage systems.

2. Switchgear Assemblies Subcommittee

H. V. Nye, *chairman*
F. W. Cramer
J. M. Geiger
C. H. Kreger
E. F. Miller
G. M. Reed
H. H. Rudd
B. K. Sturgis
O. B. Vikoren
C. P. West
W. F. Wetmore

3. Switches, Fuses, and Insulators Subcommittee

H. H. Rudd, *chairman*
K. J. C. Falck
A. H. Powell
H. L. Rawlins
R. L. Webb
J. C. Woods

The following working groups have been set up within this subcommittee:

A—Air switches and insulators (H. L. Rawlins, *chairman*).
B—Interrupter switches (H. H. Powell, *chairman*).
C—Fuses (R. L. Webb, *chairman*).

4. Subcommittee on High Voltage Switching (Where Out of Phase Voltages Exist at Time of Arc Interruption)

K. J. Falck, *chairman*
W H. Black
R. E. Enns
C.M. Ferrill
G. D. Floyd
I. W. Gross
E. L. Harder
M. H. Hobbs
C. B. Kelley
H. V. Nye

5. Incompleted Projects

The incompleted projects carried over from the protective devices committee of 1947–8 are

(*a*). Completion of Standards for automatic reclosers for a-c distribution circuits.

(*b*). Revision of Switchgear Assembly Standard 27.

(*c*). Review Standards for low-voltage air circuit breakers, which were issued for a one year trial period in December 1946.

(*d*). Complete work on calculations of short-circuit currents for low voltage.

(*e*). Complete work on revisions of short-circuit calculation and application factors for power circuit breakers.

(*f*). Complete test code for power circuit breakers.

(*g*). Revise AIEE Standard 19 (ASA *C-37*) to include temperature limits for oilless circuit breakers.

(*h*). Study rating factors for oil and oilless circuit breakers.

(*i*). Complete revisions of AIEE Standard 22 for air switches and bus supports.

6. New Projects

(*a*). Study of H. H. Rudd's proposed supplement to AIEE Standard 2, Guiding Principles for Impulse Insulation Co-ordination.

(*b*). Prepare a test code for low-voltage circuit breakers.

(*c*). Prepare Standards for automatic short-circuiting devices.

(*d*). Co-operate with ASA *C-42* Committee on revision of "Definitions of Electrical Terms."

System Engineering

E. Wild, *chairman*, Commonwealth Edison Company, 72 West Adams Street, Chicago 90, Ill.

C. G. Adams
C. P. Almon, Jr.
John Bankus
G. Bissett
M. L. Blair
R. Brandt
O. A. Demuth
A. G. Dewars
G. D. Floyd
A. P. Fugill
E. E. George
A. C. Gohlke
G. H. Groh
E. T. B. Gross
W. D. Hardaway
H. L. Harrington
A. P. Hayward
J. B. Hodtum
R. G. Hooke
L. F. Hunt
L. R. Janes
Alva A. Johnson
B. M. Jones
C. B. Kelley
M. H. Lovelady
O. W. Manz, Jr.
V. M. Marquis
C. W. Mayott
S. B. Morehouse
F. Oppenheimer
C. B. Signor
W. O. Smith
M. L. Waring
G. S. Whitlow

SYSTEM ENGINEERING SUBCOMMITTEES

1. Administrative Subcommittee

Scope: To serve as an executive committee in the assignment of work to subcommittees, to expedite work and to arrange for preparation and presentation of papers at meetings.

E. Wild, *chairman*
R. Brandt
H. L. Harrington
A. P. Hayward
R. G. Hooke
L. F. Hunt
B. M. Jones
C. W. Mayott
O. W. Manz Jr.
C. N. Metcalf

2. System Planning Subcommittee

Scope: Investigation and study of load growth and generation requirements, interconnection of systems methods of transmission and interconnection, location and optimum sizes of units, and general system planning studies.

H. L. Harrington, *chairman*
C. G. Adams
R. Brandt
A. G. Dewars
A. P. Fugill
E. T. B. Gross
W. D. Hardaway
J. B. Hodtum
R. G. Hooke
L. R. Janes
A. A. Johnson
B. M. Jones
A. A. Kroneberg
H. P. St. Clair
C. B. Signor
N. N. Smeloff
M. L. Waring
M. Ward

3. System Operations Subcommittee

Scope: Investigation and study of load and kilovar dispatching, spinning reserve, emergency procedures, resynchronizing procedures, requirements and usage of communication equipment, safety "hold-off procedures," functions of intersystem operating committees, and other general studies for improvement of system operation.

O. W. Manz, Jr., *chairman*
J. Bankus
G. Bissett
M. L. Blair
O. A. Demuth
G. D. Floyd
G. H. Groh
L. F. Hunt
C. B. Kelley
F. Oppenheimer
H. W. Phillips
W. O. Smith

4. System Economics Subcommittee

Scope: Investigation and study of interconnection operation, economics of long high-voltage power transmission, co-ordination of operation of units in a plant, between plants in a system, and between systems and other economic studies for improved system operation.

A. P. Hayward, *chairman*
E. C. Brown
E. E. George
V. M. Marquis
R. T. Purdy
J. A. Rose
C. W. Watchorn
A. L. Williams

5. System Controls Subcommittee

Scope: Investigation and study of load-frequency control equipment and operation, voltage control, phase angle control, and other general studies of control methods to improve system operations.

R. Brandt, *chairman*
C. G. Adams
C. P. Almon, Jr.
D. H. Cameron
T. E. Curtis
A. C. Gohlke
A. A. Johnson
C. N. Metcalf
S. B. Morehouse
R. E. Pierce
G. S. Whitlow

6. Interconnection Contracts Subcommittee

Scope: Investigation and study as to important features of interconnection contracts, economic interchange, emergency requirements and metering requirements, and other matters of interest to improve interconnection relations.

C. W. Mayott, *chairman*
E. D. Early
E. E. George
G. A. Grimm
N. B. Hinson
C. B. Kelley
M. H. Lovelady
V. M. Marquis
R. Martindale

Transformers

H. B. Keath, *chairman*, Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis 14, Mo.

J. A. Adams
F. S. Brown
M. K. Brown
R. J. Brown
J. L. Cantwell
J. H. Chiles
J. E. Clem
G. W. Clothier
Merrill DeMerit
J. A. Elzi
M. M. Ewell
C. G. Friddle
I. W. Gross
J. B. Hodtum
W. G. James
A. A. Johnson
D. L. Levine
H. C. Louis
C. M. Lovell
V. M. Montsinger
M. H. Pratt
T. D. Reimers
W. C. Sealey
F. L. Snyder
Paul A. Vance
F. J. Vogel
C. V. Waddington
H. H. Wagner
C. E. Winegartner

TRANSFORMERS SUBCOMMITTEES

1. Working Group on Co-ordinated Study of Life of Transformer Insulation

V. M. Montsinger, *chairman*

2. Working Group on Routine Measurement of Hot Spot Temperature Rise

W. C. Sealey, *chairman*

3. Instrument Transformer Subcommittee

Transformer Committee Representatives:
J. E. Clem, *chairman*
E. C. Wentz
D. R. Laib

Relay Committee Representatives:
R. B. Cordray
T. R. Halman
W. A. Lewis
W. E. Marter
W. K. Sonneman

Switchgear Committee Representatives:
J. M. Geiger
K. J. C. Falck
H. Bany
C. A. Woods

Instruments and Measurements Committee Representatives:
J. H. Chiles
A. B. Craig
J. P. Scott
F. B. Silsbee

Transmission and Distribution Committee Representatives:
J. B. Hodtum
L. M. Moore

Carrier-Current Committee Representative:
L. F. Kennedy

Working Group Chairmen:
W. E. Marter, relaying performance of current transformers
E. C. Wentz, test code
L. F. Kennedy, rating factors

4. Working Group on Accuracy of Voltage Regulator Control Devices

A. A. Johnson, *chairman*

5. Working Group on Operating Guides for Regulators

A. A. Johnson, *chairman*

6. Working Group on Short-Circuit Thermal Ratings of Induction and Step-Type Regulators

A. A. Johnson, *chairman*

7. Working Group on Magnetization Characteristics of Transformers

J. E. Clem, *chairman*

8. Working Group on Revision of Dielectric Tests

F. J. Vogel, *chairman*

9. Working Group on Temperature Limits of Silicon Insulation Used in Transformers

V. M. Montsinger, *chairman*

10. Working Group on Proposed Revision of A.S.A. Rules in Connection with Short-Circuit Requirements of Transformers

V. M. Montsinger, *chairman*

11. Working Group on Care and Operation of Dry Type Transformers

J. A. Adams, *chairman*

12. Working Group on Co-ordination of Insulation

J. E. Clem, *chairman*

Transmission and Distribution

C. F. Wagner, *chairman*, Westinghouse Electric Corporation, central station engineering department, East Pittsburgh, Pa.

C. E. Baugh
E. D. Bent
D. K. Blake
B. Brady
T. J. Brosnan
H. E. Carson
Harold Cole
S. B. Crary
P. J. Croft
A. E. Curtis
H. A. Dambly
A. E. Davison
E. W. Dillard
W. B. Fisk
I. W. Gross
J. H. Hagenguth
K. E. Hapgoodson
E. R. Hendrick
J. B. Hodtum
E. K. Huntington
Arthur A. Jones
C. H. Kraft
A. A. Kroneberg
J. T. Lusignan
D. W. Nethercut
J. E. O'Brien
E. W. Oesterreich
J. S. Parsons
C. K. Poarch
L. M. Robertson
F. E. Sanford
E. V. Sayles
H. J. Scholz
A. N. Shealy
A. E. Silver
F. V. Smith
E. C. Starr
H. M. Trueblood
E. R. Whitehead
R. L. Witzke
H. E. Wulfing

TRANSMISSION AND DISTRIBUTION SUBCOMMITTEES

1. Capacitor Subcommittee

F. V. Smith, *chairman*
M. I. Alimansky
G. Appleman
C. E. Baugh
E. W. Dillard
R. H. Earle
K. E. Hapgood
E. R. Hendrickson
R. E. Marbury
N. A. Miller
R. B. Miller
C. E. Parks
W. L. Steinbarge
L. T. Williams

Projects:

(*a*). Revision of Standard *C55* (1934) of capacitors.

(*b*). Report on operating practice—fusing practice, circuit characteristics, grounding of neutral, telephone switching, and so forth, in an operating guide.
E. R. Hendrickson, *chairman*

(*c*). Study of troubles with capacitors.
C. E. Parks, *chairman*

2. Distribution Subcommittee

Harold Cole, *chairman*
D. K. Blake
T. J. Brosnan
E. R. Henrrickson
J. B. Hodtum
D. W. Nethercut
E. W. Oesterreich
J. S. Parsons
R. R. Robinson
F. E. Sanford

Projects:

(*a*). Joint working group with transmission systems.
T. J. Brosnan E. R. Hendrickson J. S. Parsons

(*b*). Working group on primary systems.
D. K. Blake L. M. Robertson F. E. Sanford

(*c*). Distribution transformers to the customer.

3. General Systems Subcommittee

S. B. Crary, *chairman*
O. A. Demuth
L. B. LeVesconte
R. G. Hooke
E. K. Huntington
A. A. Kroneberg
E. L. McClure
L. M. Robertson
H. M. Trueblood
R. L. Witzke

Projects:

(*a*). Subject committee on line outages (joint with EEI).
R. W. Caswell
G. D. Floyd
K. W. Hapgood
M. H. Pratt (*for EEI*)
H. M. Trueblood
R. L. Witzke

(*b*). Report on power system overvoltages.

(*c*). Frequency changeover.

(*d*). Contamination and life of insulators.

4. Lightning and Insulator Subcommittee

J. T. Lusignan, *chairman*
H. N. Ekvall
H. A. Frey
I. W. Gross
E. L. Harder
W. W. Lewis
G. D. McMann
S. K. Waldorf
E. R. Whitehead

Projects:

(*a*). Recommendations for lightningproof lines.
E. R. Whitehead, *chairman*

(*b*). Impulse characteristics of insulators, wood, and air in series.

(*c*). Insulator contamination and corrective measures.

(*d*). Insulator flashover characteristics.

5. Towers, Poles, and Conductors Subcommittee

A. E. Davison, *chairman*
N. K. Barr
C. A. Booker
P. J. Croft
A. L. Duna
E. Hansson
E. L. Kanouse
W. I. Middleton
A. A. Osipovich
J. A. Rawls
A. S. Runciman
E. J. Staubitz
G. W. Stickley

Industry Group

Industry Co-ordinating Committee

J. J. Orr, *chairman*, United States Rubber Company, 1230 Sixth Avenue, New York 20, N. Y.

T. R. Rhea
Victor Siegfried
Ex-officio
Chairmen of the seven following technical committees in the industry group

Chemical, Electrochemical, and Electrothermal Applications

F. R. Benedict, *chairman*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

F. V. Andreae
J. D. Brance
W. H. Dickinson
W. C. Dreyer
M. E. Gamble
Felix Glaza
L. Goldsmith
L. O. Grondahl
W. E. Gutzwiller
E. A. Hanff
C. W. Hansell
J. D. Harper
T. G. Hieronymus
J. E. Hobson
H. E. Houck
J. D. Huntsberger
M. A. Hyde, Jr.
Rollin Kennard
E. L. Kirk
R. J. Kuhn
E. H. Lamberger
D. H. Levy
J. A. McLellan
G. H. Orcutt
Waldo Porter
D. Ramadanoff
R. L. Rayner
T. R. Rhea
H. C. Riggs
L. W. Roush
E. T. Rummel
G. B. Scheer
E. H. Scheick
E. O. Scott
I. R. Smith
Joel Tompkins
J. J. Unger
G. W. Vinal
H. W. Wahlquist
H. H. Zielinski

CHEMICAL, ELECTROCHEMICAL, AND ELECTROTHERMAL SUBCOMMITTEES

1. Arc Furnaces and Electrothermal Processes Subcommittee

E. H. Browning, Jr., *chairman*
F. V. Andreae
F. R. Benedict
W. L. Bundy
E. A. Hanfl
A. R. Oltrogge
E. Scheick
H. H. Zielinski

2. Cathodic Protection Subcommittee

Scope: To develop the electrical engineering aspects of the application of cathodic protection. To promote a general understanding of those factors, under the control of designing and operating engineers, that contribute to corrosion and to its mitigation. To prepare a technical paper on the subject of electrical design from the standpoint of reduction of corrosion.

E. L. Kirk, *chairman*
A. E. Archambault
J. D. Brance
A. S. Brooks
Guy Corfield
C. G. Cox
I. A. Dennison
L. J. Gorman
T. G. Hieronymus
R. J. Kuhn
D. H. Levy
R. L. Rayner
H. W. Wahlquist

3. Electrolytic Processes Subcommittee

Scope: Treatment of all matters relative to electrolytic processes such as electrodeposition, electrolytic refining, electrolytic reduction, alkali chloride electrolysis, aqueous electrolytic processes. Such subjects as theory, technique, efficiency, plant, electrolytic cells, application of power conversion equipment, specialized equipment, and operating hazards are within the scope of this subcommittee.

W. E. Gutzwiller, *chairman*
Felix Glaza
J. D. Harper
H. E. Houck
F. L. Kaestle
Rollin Kennard
F. L. Lawton
G. H. Orcutt
Waldo Porter
G. B. Scheer
J. Tompkins

4. Metallic Rectifiers Subcommittee

Scope: This subcommittee so far has completed a set of standard definitions, a bibliography, and a patent list on metallic rectifiers. It is working now on a test code and also is collaborating with the United States Army and Navy in connection with the issuance of a Joint Army-Navy specification on metallic rectifiers. This subcommittee has future plans to issue standards for metallic rectifiers, as well as delve into the theoretical aspects of these rectifiers.

L. O. Grondahl, *chairman*
E. A. Harty, *secretary*
W. F. Bonner
L. W. Burton
P. G. Cobb
M. E. Gamble
K. S. Geiges
E. A. Groeteke
C. E. Hamann
C. W. Hansell
C. C. Herskind
W. E. Phillips
N. Y. Priessman
C. G. Ramsey
I. R. Smith
D. Trucksess
J. Yarmack
S. Zwerling

5. Petroleum Refining and Production Subcommittee

Lester Goldsmith, *chairman*
H. J. Appel
W. H. Dickinson
J. B. Glasby
E. L. Hoyle
D. H. Levy
E. L. Nopper
L. E. Priester

6. Storage Batteries Subcommittee

Scope: This subcommittee has as its function the fostering of technical papers and the establishment of AIEE Standards, where needed, on all phases of storage battery design and engineering.

H. C. Riggs, *chairman*
J. D. Huntsberger
L. A. Murray
E. T. Rummel
J. J. Unger
K. A. Vaughn
H. H. Zielinski

7. Chemical Industries Subcommittee

L. W. Roush, *chairman*
Felix Glaza
H. E. Houck

Electric Heating

G. W. Scott, Jr., *chairman*, Armstrong Cork Company, Lancaster, Pa.

E. L. Bailey
R. M. Baker
E. H. Browning
Harold Bunte
F. T. Chesnut
L. M. Duryee
R. H. Ellis
P. G. Goodell
J. Grotzinger
J. C. Handy
E. A. Hanfl
J. B. Hodtum
L. P. Hynes
T. P. Kinn
G. F. Leland
F. H. Mason
W. H. Meyer
L. R. Milburn
R. Neighbours
A. E. Opdenweyer
C. E. Peck
K. Pinder
J. B. Rice
W. C. Rudd
E. H. Scheick
W. R. Schofield
G. S. Smith
T. H. Story
J. T. Thwaites
G. E. Walters
H. R. Winemiller

ELECTRIC HEATING SUBCOMMITTEES

1. Electronic Heating Subcommittee

Scope: Study of the problem of interference from electronic heating equipment (with the advance of the Electronic Heating Subcommittee, the Federal Communications Commission has formulated regulations regarding the allowable limit of radiation from electronic heating equipment). Formulation of the principles of good engineering practice to deal with intolerable interference. Development of an AIEE Standard for electronic heating equipment including definitions of electronic heating terms.

W. C. Rudd, *chairman*
W. R. G. Baker
G. P. Bosomworth
L. W. Chapin
F. Chesnut
Harold E. Dinger
L. M. Duryee
J. E. Eiselein
C. W. Frick
H. C. Gillespie
W. H. Hickok
R. J. Hunn
R. L. Uphofl
T. R. Kennedy
T. P. Kinn
W. H. Meyer
Loyal R. Milburn
Eugene Mittelman
G. W. Scott, Jr.
J. T. Thwaites
G. E. Walters
D. E. Watts
Otto Weitmann
H. R. Winemiller
A. C. Wooldridge

2. Radiant Heating Subcommittee

Scope: Standardization of lamp-type heating in all its phases. The advantages and limitations of infrared heating will be emphasized for the benefit of the engineering profession. It will cover the construction, optics, thermodynamics, and safety considerations associated with all high temperature sources, correlation with other forms of electric heating, but not to include space heating.

Paul H. Goodell, *chairman*
C. E. Russell, *secretary*
I. J. Barber
E. J. Bates
Earl Benson
P. O. Blackmore
A. H. Canada
Charles A. Casey
H. J. Garber
E. D. Haigler
S. G. Hibben
J. E. Johanson
E. A. Linsday
A. D. Moore
C. T. Prendergast
G. W. Scott, Jr.
Lawrence Stout
J. E. Sump
Ernest Upton
W. H. Wagner

3. Subcommittee on Radiation Measurements Above 200 Megacycles

Scope: All methods of measuring radiation up to and above 200 megacycles are being studied. Actual experimental work in various laboratories is being undertaken to develop methods of measurement in the frequency ranges where a satisfactory method does not now exist and to improve methods in those ranges where some work has been done to date.

R. M. Baker, *chairman*
H. H. Beizer
Marvin Bock
R. E. Burgess
E. W. Chapin
Lucien Clarke
A. J. Vadasz
H. E. Dinger
J. E. Eiselein
C. W. Frick
G. W. Scott, Jr.
Ralph M. Showers
H. E. Sorrows

4. Resistance Heating and Electric Furnaces Subcommittee

Scope: To study and promulgate information on the use of resistance heating and electric furnaces in industry including such standardization as may be necessary.

L. P. Hynes, *chairman*
F. E. Bash
Mark M. Greer
J. C. Handy
A. G. Hotchkiss
C. E. Peck
K. Pinder
David Y. Robinson
E. H. Scheick

Electric Welding

E. H. Vedder, *chairman*, Westinghouse Electric Corporation, P. O. Box 2025, Buffalo 3, N. Y.

E. M. Callender
G. M. Chute
C. N. Clark
W. E. Crawford
J. F. Deflenbaugh
R. C. Freeman
G. W. Garman
J. C. Learman
W. M. McKie
R. C. McMaster
C. M. Rhoades, Jr.
F. Rothganger
J. R. Sellenberg
Sam Shiozawa
C. E. Smith
H. W. Snyder
H. I. Stanback
E. F. Steinert
L. K. Stringham
G. I. F. Theriault
H. W. Tietze
A. M. Unger
F. J. Wells
B. L. Wise
R. E. Young
Myron Zucker

ELECTRIC WELDING SUBCOMMITTEES

1. Power Supply for Resistance Welding Machines Subcommittee

Scope: Provision of basic information relating to power requirements and the effect of resistance welding load from the standpoint of both users and utilities. Outline economic considerations in the purchase and utilization, as well as provision of power, for welding including power factor correction, combined power and welding facilities, and so forth. Set up desirable practices and methods of procedure to be used in the selection of adequate power facilities for resistance welding.

C. M. Rhoades, Jr., *chairman*
W. H. Allen
W. G. Bostwick
W. W. Brumby
C. N. Clark
E. F. Dissmeyer
R. S. Phair
C. E. Smith
J. L. Solomon
C. B. Stadum
H. W. Tietze
Myron Zucker

2. Resistance Welding Subcommittee

C. E. Smith, *chairman*
E. M. Callender
Myron Zucker
C. N. Clark
G. W. Garman

3. Arc Welding Subcommittee

E. F. Steinert, *chairman*
C. N. Clark
E. L. Hansen
R. R. LoBosco
C. I. MacGuffie
H. W. Snyder

General Industry Applications

L. A. Umansky, *chairman*, General Electric Company industrial engineering divisions, 1 River Road, Schenectady 5, N. Y.

B. T. Anderson
A. T. Bacheler
S. A. Bobe
D. C. Christison
J. M. Delfs
J. C. Fink
A. W. Frankenfield
J. A. Gienger
E. M. Hays
F. B. Haeussler
L. W. Herchenroeder
K. W. John
V. O. Johnson
G. W. Knapp
A. F. Lukens
Joseph Manuele
E. F. Mekelburg
J. F. Moore
E. K. Murphy
D. R. Percival
Kennard Pinder
H. A. Rose
H. L. Smith
R. H. Smith
F. D. Snyder
R. F. Snyder
Ray Stroppel
W. B. Wigton

GENERAL INDUSTRY APPLICATIONS SUBCOMMITTEES

1. Machine Tools Subcommittee

W. B. Wigton, *chairman*
B. T. Anderson
E. L. Bailey
J. M. Delfs
R. E. Stroppel
J. M. Dickenson
L. W. Herchenroeder
E. F. Mekelburg
D. R. Percival

2. Materials Handling Subcommittee

E. M. Hayes, *chairman*
E. L. Blankenbeker, *secretary*
Fred W. Atz
O. M. Bundy
M. A. de Ferranti
E. O. Dunham
T. O. English
D. C. Gray
R. W. Mallick
A. H. Myles
E. J. Posselt
E. C. Rice
C. B. Rissler
G. W. Yanney

3. Pulp and Paper Industry Subcommittee

G. W. Knapp, *chairman*
V. B. Baker
H. B. Barrow
A. C. Bird
D. C. Christison
Ray Smith
Floyd L. Davis
Oscar O. Fisk
E. K. Murphy
H. Ostertag
H. A. Rose

4. Rubber and Plastics Industries Subcommittee

K. W. John, *chairman*
A. T. Bacheler
P. S. Bechtol
B. J. Dalton
J. A. Gienger
R. F. Snyder
V. O. Johnson
G. V. Kullgren
B. D. Morgan
W. J. Secrest
H. L. Smith

5. Textile Industry Subcommittee

F. D. Snyder, *chairman*
S. A. Bobe
R. J. Demartini
A. W. Frankenfield
H. Haley
F. B. Hauessler
L. T. Jester
A. P. Lewis
D. McConnell
Victor Sepavich
R. S. Stribling
H. C. Uhl

Industrial Control

J. D. Leitch, *chairman*, Electric Controller and Manufacturing Company, 2700 East 79th Street, Cleveland 4, Ohio

E. H. Alexander
H. H. Angel
F. J. Bartholomew
L. J. Conover
J. A. Cortelli
R. H. Ellis
C. T. Evans
L. E. Fisher
D. K. Frost
J. E. Gahagan
J. A. Gienger
G. W. Heumann
Kurt John
R. W. Jones
E. U. Lassen
L. H. Matthias
E. F. Mekelburg
M. Michel
T. B. Montgomery
E. E. Moyer
L. B. Murray
H. L. Palmer
J. W. Picking
L. T. Rader
G. H. Rendel
E. J. Rivoira
J. B. Russell
W. Schaelchlin
R. E. Schuette
A. G. Turnbull
E. H. Vedder
H. R. Walker

INDUSTRIAL CONTROL SUBCOMMITTEES

1. Bibliography Subcommittee

R. W. Jones, *chairman*

2. Electronic Control Subcommittee

Scope: The treatment of all matters in which the dominant factors are the design, construction, and functioning of electronic industrial controls exclusive of those controls and functions that specifically are assigned to other technical committees.

H. L. Palmer, *chairman*
F. T. Bailey
H. B. Black
S. L. Burgwin
C. J. Collom
Ben Cooper
E. T. Davis
W. H. Elliot
William Few
E. W. Hutton
L. U. C. Kelling
O. W. Livingston
F. G. Logan
E. B. McDowell
J. W. Picking
V. J. Porter
K. P. Puchlowski
W. G. Roman
C. A. Schurr
W. W. Snyder
H. I. Stanback
B. B. Stuart
C. M. Summers
B. F. Tellkamp

Working Groups:

(*2-1*). Electronic Control of D-C Motors
J. W. Picking, *chairman*
H. B. Black
C. J. Collom
Ben Cooper
W. H. Elliott
William Few
F. G. Logan
W. G. Roman
H. I. Stanback
B. B. Stuart
B. F. Tellkamp

(*2-2*). Photoelectric Pickup Systems
L. U. C. Kelling, *chairman*
F. T. Bailey

(*2-3*). Electronic Relaying Devices
E. B. McDowell, *chairman*
K. P. Puchlowski
C. A. Schurr
B. F. Tellkamp

(*2-4*). Electronic Regulators and Regulating Systems
O. W. Livingston, *chairman*
H. B. Black
S. L. Burgwin
E. T. Davis
W. H. Elliot
William Few
F. G. Logan
J. W. Picking
W. W. Snyder

(*2-5*). Electronic Control of A-C Power
E. W. Hutton, *chairman*
H. B. Black
W. H. Elliot
F. G. Logan
W. G. Roman
B. F. Tellkamp

3. Standards Subcommittee

Scope: This subcommittee will prepare proposals for revised and new Standards pertaining to industrial control in which AIEE is interested, especially AIEE Standard 15 which is also ASA Standard C19.1. Such proposals are in preparation to action taken by official AIEE members on the respective ASA committees. The work of co-ordinating is carried on by the subcommittee chairman who assembles working groups from time to time as the need for action on existing or new Standards arises.

G. W. Heumann, *chairman*

4. Test Codes Subcommittee

Scope: The proposed test code should contain recommendations for test procedure and test methods, as applied to industrial control equipment. The test methods recommended should be such that the tests made at different times and by different laboratories will be comparable and significant. It is desirable that the test procedures be such that the results of the tests may be interpreted and expressed in some defined scale of comparison, but it is not the purpose of the test code to set standards of acceptability. Neither should the test code attempt to determine or specify what type of investigation need be made on any given type of apparatus. It is the consensus of opinion that the efforts of the subcommittee should be concentrated on the more fundamental tests relating to basic design rather than on routine production tests.

C. T. Evans, *chairman*
D. K. Frost
B. W. Jones
H. E. Nason
W. E. Pakala
H. E. Ryan
C. A. Schaefer

Industrial Power Systems

D. L. Beeman, *chairman*, General Electric Company, industrial engineering divisions, 1 River Road, Schenectady 5, N. Y.

W. M. Ballenger
H. G. Barnett
W. C. Bloomquist
E. S. Dibble
Felix Glaza
J. S. Gault
W. N. Goodridge
W. S. Gordon
D. C. Gray
L. N. Grier
W. R. Harmer
C. F. Hedlund
C. R. Johnson
R. E. Johnson
C. M. Lathrop
M. C. Mapes
A. E. Marshall
J. L. McKeever
J. S. Morgan
W. A. Mcsteller
J. S. Parsons
R. C. Peters
C. G. Plomasen
Dick Ray
W. H. Rollman
F. Rothganger
R. C. Setterstrom
R. R. Shollenberger
J. F. Spease
H. C. Swannell
T. O. Sweatt
B. F. Thomas
S. A. Warner
R. W. Watson
William Zelley
T. O. Zittel

INDUSTRIAL POWER SYSTEMS SUBCOMMITTEES

1. Subcommittee on Interior Wiring Design for Commercial Buildings

B. F. Thomas, Jr., *chairman*
L. W. McCullough, *secretary*
F. R. Benedict
C. D. Bratiotis
Leo H. Cleary
Allan Coggeshall
W. T. Crosman
R. F. Davis
V. E. Dodson
C. F. Hedlund
James A. Heffernan
Ralph C. Hodges
R. H. Kaufmann
George K. Perley
L. C. Peterman
H. F. Richardson
C. W. Schemm
C. F. Scott
B. Z. Segall
Herbert Speight
Howard R. Stevenson
T. O. Sweatt
W. Weinerth

2. Subcommittee on Revision of Electric Power Distribution for Industrial Plants

John Grotzinger, *chairman*
J. A. Arberry
G. E. Baker
H. G. Barnett
E. T. Carlson
R. F. Davis
Wm. Deans
D. D. Douglass
W. C. Bloomquist
L. E. Fisher
C. R. Johnson
N. B. Lainge
S. W. Luther
R. B. McKinley
J. S. Parsons
R. C. R. Schulze
E. E. Turkington
R. J. Wiseman

3. Transformer Voltage Ratios Subcommittee

H. G. Barnett, *chairman*
D. L. Beeman
S. F. French
J. Grotzinger
K. Pinder
T. O. Sweatt
C. C. Whipple

Mining and Metal Industry

F. W. Cramer, *chairman*, Carnegie-Illinois Steel Corporation, Carnegie Building, Fifth Avenue, Pittsburgh 19, Pa.

G. Bright
M. K. Clay
R. J. Corfield
J. A. Cortelli
E. W. Davis
J. M. Downie
J. H. Edwards
R. H. Ellis
J. R. Erbe
Cecil Farrow
James J. Fitzgibbon
R. W. Graham
Lanier Greer
L. N. Grier
W. R. Harris
L. H. James
C. F. King, Jr.
R. C. McMaster
W. E. Miller
T. B. Montgomery
A. C. Muir
H. P. Musser
Bailey E. Price
D. E. Renshaw
E. G. Schlup
F. O. Schnure
Victor Siegfried
O. J. Swanson
C. L. Tyler
T. R. Weichel
A. J. Whitcomb
C. O. Wood
T. O. Zittel

MINING AND METAL INDUSTRY SUBCOMMITTEES

1. Metal Industries Subcommittee

T. B. Montgomery, *chairman*
J. A. Cortelli
R. H. Ellis
J. R. Erbe
Cecil Farrow
L. N. Grier
W. R. Harris
C. F. King
W. E. Miller
Bailey Price
E. G. Schlup
F. O. Schnure
Victor Siegfried
A. J. Whitcomb

2. Mining Subcommittee

A. C. Muir, *chairman*
Graham Bright
M. K. Clay
R. J. Corfield
E. W. Davis
John M. Downie
J. H. Edwards
L. H. James
James J. Fitzgibbon
R. C. McMaster
H. P. Musser
D. E. Renshaw
O. J. Swanson
C. L. Tyler
T. R. Weichel
C. O. Wood

Communication and Science Group

Communication and Science Co-ordinating Committee

J. D. Tebo, *chairman*, Bell Telephone Laboratories, 463 West St., New York 14, N. Y.

J. L. Callahan
I. Melville Stein

Ex-officio

Chairmen of the seven following technical committees in the communication and science group

Basic Sciences

Walther Richter, *chairman*, Allis-Chalmers Manufacturing Company, West Allis, Wis.

J. A. Becker
J. G. Brainerd
C. R. Burrows
F. M. Clark
C. Concordia
P. C. Cromwell
A. V. Eastman
E. A. Gaugler
W. C. Hall
C. R. Hanna
C. W. Hansell
F. K. Harris
H. L. Hazen
N. S. Hibshman
T. J. Higgins
W. C. Johnson
H. P. Lawther
W. A. Lewis
T. H. Long
M. G. Malti
W. H. MacWilliams, Jr.
G. D. McCann
K. W. Miller
W. E. Phillips
H. J. Plumley
J. B. Russell
W. J. Seeley
J. J. Smith
L. A. Smith
V. G. Smith
F. G. Tappen
J. D. Tebo
F. E. Terman
G. S. Timoshenko
T. D. Yensen

BASIC SCIENCES SUBCOMMITTEES

1. Applied Mathematics Subcommittee

Scope: To furnish needed co-operation between mathematicians and engineers, preferably by bringing specific engineering problems to the attention of mathematicians for solution rather than to consider only general problems which might be discussed from an abstract viewpoint. Members of the American Mathematical Society are invited to join with this subcommittee in mutually advantageous conferences and sessions.

M. G. Malti, *chairman*
P. L. Alger
Henry B. Hansteen
J. J. Smith
Harry Sohon

2. Electric Circuit Theory Subcommittee

Scope: Considerable work in circuit theory has been done, particularly as a result of the war effort. The function of this subcommittee is to make a thorough review of recent circuit theory developments in all fields directed toward the publication of this material and also to study circuit theory definitions which are needed urgently in view of the almost complete lack of standard circuit theory definitions existing at the present time.

J. G. Brainerd
R. L. Dietzold
E. A. Guillemin
T. J. Higgins
F. J. Maginnis
W. O. Osbon
E. B. Payne
W. E. Phillips
E. Weber

3. Energy Sources Subcommittee

Scope: The great impetus given to new methods of supplying electric power by developments in nuclear energy has suggested that all known methods of producing electric power should be reviewed in the light of present-day knowledge. This subcommittee is conducting conferences to review the various known means of electric energy generation, efforts being made to prepare for publication papers by outstanding experts in their respective fields.

W. A. Lewis, *chairman*
W. C. Brown
M. A. Gartens
C. R. Hanna
L. W. Matsch
Walther Richter
J. J. Smith
B. R. Teare
J. D. Tebo

4. Electrical Properties of Solids Subcommittee

Scope: Treatment of the theories explaining the electrical properties of various types of solid materials commonly used in electrical engineering, such as thermionic emission, semiconductors, dielectrics, and magnetism.

Joseph A. Becker, *chairman*
Stephan Angello
J. P. Barton
Saul Dushman
R. W. Engstrom
F. K. Harris
K. Lark-Horovitz
P. H. Miller, Jr.
Fred Seitz
Lloyd Smith
A. Von Hippel
Dean W. Wooldridge

5. Subcommittee on Magnetics

T. D. Yensen, *chairman*
J. P. Barton
R. M. Bozorth
G. H. Cole
E. A. Gangler
S. L. Quimby
W. E. Ruder
Van Vleck
H. G. Zambell

6. Subcommittee on Electrical Properties of Liquids and Gases.

(*Personnel to be selected*)

Communication

Rothwell E. Smith, *chairman*, International Telephone and Telegraph Corporation, 67 Broad Street, New York 4, N. Y.

L. G. Abraham
H. A. Affel
A. L. Albert
W. M. Allen
G. M. K. Baker
E. D. Becken
J. D. Booth
F. B. Bramhall
A. J. Busch
I. F. Byrnes
J. L. Callahan
J. O. Carr
J. B. Coleman
L. G. Cumming
C. E. Dean
M. Eastham
H. E. Ellithorn
A. E. Frost
J. C. Gaudio
D. G. Geiger
P. C. Goldmark
T. T. Goldsmith, Jr.
G. H. Gray
L. B. Grew
H. H. Haglund
W. D. Hailes
L. C. Holmse
E. M. Johnson
P. L. Johnson
F. W. Kenefake
R. H. Kline
H. P. Lawther
M. Levy
G. A. Locke
R. E. Mathes
G. R. Messmer
J. L. Middlebrooks
F. E. Norris
R. R. O'Connor
L. G. Pacent
E. G. Ports
R. H. Ranger
G. B. Ransom
W. A. Ready
F. M. Rives
H. I. Romnes
G. T. Royden
A. L. Rumsey
J. B. Russell
R. E. Shelby
A. B. Smith
J. E. Smith
W. T. Smith
S. C. Spielman
R. B. Vaile, Jr.
W. E. Vellines, Jr.

COMMUNICATION SUBCOMMITTEES

1. Co-ordinating Committee

Scope: To act as liaison between the technical program committee and the working units of the communication committee.

R. E. Smith, *chairman*
F. B. Bramhall, *secretary*
J. L. Callahan, *junior past chairman*
H. I. Romnes, *vice-chairman*

Subcommittee chairmen:

H. A. Affel
J. D. Booth
A. J. Busch
G. H. Gray
H. H. Haglund
E. G. Ports
F. M. Rives
R. E. Shelby
S. C. Spielman

2. Communications Standards Subcommittee

Scope: To co-ordinate with other working units on standards insofar as it may concern communications.

G. H. Gray, *chairman*

3. Communication Switching Systems Subcommittee

Scope: Embodies telephone switching systems such as crossbar, panel, rotary and step-by-step and includes all forms of telegraph switching systems such as employed in handling switched telegraph message traffic.

A. J. Busch, *chairman*
A. E. Frost
D. G. Geiger
G. H. Gray
L. C. Holmes
P. L. Johnson
H. P. Lawther
F. E. Norris
Arthur Bessey Smith

4. Wire Communication Systems Subcommittee

Scope: Covers wire transmission systems and associated apparatus as applied to open wire lines, land and submarine cables for providing telephone, telegraph, broadcast, and television program services.

H. A. Affel, *chairman*
L. G. Abraham
Arthur L. Albert
W. M. Allen
H. E. Ellithorn
G. H. Gray
H. H. Haglund
R. R. O'Connor
G. B. Ransom
A. L. Rumsey
Arthur Bessey Smith

5. Home Radio Receivers Subcommittee

Scope: This subcommittee comprises activities related to amplitude modulation, frequency modulation, and television receivers used for the reception from radiobroadcasting stations.

S. C. Spielman, *chairman*
J. B. Coleman
L. G. Cumming
C. E. Dean
J. C. Gaudio
P. C. Goldmark
T. T. Goldsmith, Jr.
E. W. Kenefake
M. Levy
H. W. Schaefer

6. Power Line Carrier Systems Subcommittee

Scope: This subcommittee would join with the power group in handling all activities related to the use of carrier currents by power companies in their operations.

F. M. Rives, *chairman*
J. D. Booth
W. D. Hailes
G. R. Messmer
W. T. Smith

7. Radiobroadcasting Systems Subcommittee

Scope: This subcommittee would cover amplitude modulation, frequency modulation, and television broadcasting stations, studio equipment, television cameras, studio-transmitter links, and anything else related to the broadcasting of programs for entertainment or instruction.

R. E. Shelby, *chairman*
G. M. K. Baker
J. B. Coleman
P. C. Goldmark
T. T. Goldsmith, Jr.
E. M. Johnson
E. W. Kenefake
J. L. Middlebrooks

8. Radio Communication Systems Subcommittee

Scope: This subcommittee would cover radio communication systems of all kinds such as radio relay for telephone, television or telegraph; mobile systems for automobiles, ships, or airplanes; and point-to-point systems for telephone or telegraph.

E. G. Ports, *chairman*
G. T. Royden, *vice-chairman*
E. D. Becken
E. M. Boone
I. F. Byrnes
T. T. Goldsmith, Jr.
E. W. Kenefake
G. R. Messmer
R. H. Ranger
John B. Russell
J. Ernest Smith

9. Record Communications Subcommittee

Scope: This subcommittee would handle facsimile telephoto, magnetic recording, teletypewriters, and other similar communications involving the making of a record.

H. H. Haglund, *chairman*
E. D.Becken
J. O. Carr
G.H. Gray
L. C. Holmes
G. A. Locke
R. E. Mathes
R. H. Ranger
Arthur Bessey Smith
R. B. Vaile, Jr.

10. Special Communication Applications Subcommittee

Scope: This subcommittee would handle miscellaneous activities which do not fall within the scope of the other committees such as hearing aids, radar, and sonar.

J. D. Booth, *chairman*
R. H. Kline, *vice-chairman*
I. F. Byrnes
J. B. Coleman
Melville Eastham
W. D. Hailes
E. W. Kenefake
L. G. Pacent
W. A. Ready
R. B. Vaile, Jr.

Computing Devices

Charles Concordia, *chairman*, central station engineering divisions, General Electric Company, 1 River Road, Schenectady 5, N. Y.

J. G. Brainerd
S. H. Caldwell
E. L. Harder
J. C. McPherson
W. C. Johnson
J. W. Mauchly
G. D. McCann

COMPUTING DEVICES SUBCOMMITTEES

1. Digital Computers Subcommittee

Doctor John W. Mauchly, *chairman*

2. Continuous-Variable Computers Subcommittee

Doctor E. L. Harder, *chairman*

Electronics

C. H. Willis, *chairman*, Princeton University, Princeton, N. J.

G. M. K. Baker
W. R. G. Baker
R. Bennett
E. M. Boone
C. J. Breitwieser
C. B. Brown
G. H. Browning
C. V. Bullen
R. S. Burnap
W. R. Clark
L. G. Cowles
F. W. Cramer
G. J. Crowdes
H. F. Dart
E. V. DeBlieux
W. G. Dow
A. V. Eastman
G. V. Eltgroth
R. Feldt
D. G. Fink
K. S. Geiges
W. A. Geohegan
E. W. Greenfield
E. R. Haberland
L. P. Haner
J. D. Heibel
J. E. Hobson
J. R. Hyneman
T. P. Kinn
W. H. Lee
W. A. Leidigh
J. D. Leitch
O. W. Livingston
D. E. Marshall
R. C. Mason
F. T. McNamara
H. R. Meahl
G. A. Morton
B. K. Northrop
J. K. Nunan
D. Packard
H. L. Palmer
G. W. Penney
W. H. Pickering
O. W. Pike
A. J. Quigley
J. G. Reid, Jr.
L. E. Reukema
J. D. Ryder
E. T. Sherwood
H. B. Slade
S. W. Smith
T. Spooner
H. C. Steiner
C. M. Summers
A. A. Sylvane
E. R. Thomas
J. T. Thwaites
F. N. Tompkins
D. E. Trucksess
D. C. Ulry
W. C. White
H. Winograd
A. M. Zarem

ELECTRONICS SUBCOMMITTEES

1. Electronic Aids to Navigation Subcommittee

Scope. The formulation of definitions of radio and electronic navigational terms. This work is being coordinated with the radio technical commission for aeronautics. In future months it is expected that the committee will undertake to formulate standards of testing various radio and electrical navigation systems.

2. Electronic Precipitation Subcommittee

Scope:

1. Electrical precipitation of dust, both in air conditioning and in the removal of high concentrations of dust fume and smoke which generally has been called Cottrell precipitation.
2. Electrostatic painting and "detearing."
3. Electrostatic separation of solids.
4. Electrostatic application of abrasives and other substances in manufacturing processes.
5. Static problems in industry.

3. Electronic Papers, Meetings and Section Contacts Subcommittee

Scope: Encourages and initiates the preparation of papers on any phase of electronics.

4. High-Frequency Conductors, Cables, and Connectors Subcommittee

Scope: The subcommittee has under consideration possible standardization, procurement of technical papers, and liaison work with other technical sections in connection with high-frequency cables, conductors, and connectors. The scope of this subcommittee also will include wave guides. The subcommittee has been actively considering coaxial cables, other high-frequency wires and connectors, and test methods.

5. Hot-Cathode Electronic Power Converters Subcommittee

Scope: Preparation of standards that apply to the following types of converters: rectifiers utilizing hot cathode gas or vacuum tubes and inverters utilizing hot cathode gas tubes. This scope excludes applications in oscillator circuits and radio receivers.

6. Subcommittee for Liaison with IRE

7. Subcommittee for Liaison with JETEC (Joint Electron Tube Engineering Council)

8. West Coast Subcommittee

W. H. Pickering, *chairman*

9. Canadian Liaison Subcommittee

10. Electronic Education Subcommittee

F. N. Tompkins, *chairman*

11. Electronic Aids to Medicine Subcommittee

Scope: This subcommittee will attempt to co-ordinate medical and engineering development, acquainting the engineering profession with medical problems requiring engineering development, and acquainting the medical profession with possibilities in solution of their problems.

12. X-Ray Tubes Subcommittee

Scope: Matters pertaining to X-ray tubes, rectifier tubes used in X-ray high-voltage generators, and other electron tubes used in X-ray apparatus and accessories. It contemplates work on such projects as standardizing the method of specifying the ratings and characteristics of X-ray and rectifier tubes; standardizing the symbols and form of presenting the wiring diagrams for X-ray generators; and standardizing the method of specifying the characteristics and ratings of X-ray transformers and generators.

13. Electron Tubes Subcommittee

Scope: Treatment of all technical matters relating to the design, construction, test, and operation of electron tubes for industrial use. The committee is starting the preparation of standards. These standards will include sections on high vacuum tubes, cathode-ray tubes, gas-filled thermionic and cold cathode tubes, phototubes, and mercury-pool cathode tubes. All pertinent information such as definitions, standards, test codes, and application practice codes that is necessary to define electron tubes technically is to be included.

Working Groups:

(*13-1*). High Vacuum Tubes
(*13-2*). Cathode-Ray Tubes
(*13-3*). Gas-Filled Thermionic and Cold Cathode Tubes—Phototubes
(*13-4*). Mercury-Pool Cathode Tubes

14. Electronic Standards Subcommittee

Scope: It is the function of this subcommittee to assist the various electronic subcommittees in co-ordinating their standardizing efforts and to get them into the proper form and channels, if they are to become AIEE or American Standards. A part of this subcommittee's function is educational, in that it is attempting to show how standardization is accomplished, what national societies and associations are concerned, and how their activities are correlated.

Instruments and Measurements

E. I. Green, *chairman*, Bell Telephone Laboratories, Inc.,
463 West Street, New York 14, N. Y.

R. C. Bailey
P. A. Borden
H. H. Brauer
D. L. Brown
A. L. Brownlee
L. A. Burckmyer, Jr.
S. H. Caldwell
J. H. Chiles
W. R. Clark
J. E. Clem
A. B. Craig
C. L. Dawes
F. C. Doble
E. D. Doyle
C. K. Duff
G. W. Dunlap
W. N. Eddy
F. J. Gaffney
T. S. Gray
I. W. Gross
C. M. Hathaway
G. B. Hoadley
E. B. Kipp
W. G. Knickerbocker
A. E. Knowlton
H. C. Koenig
Everett S. Lee
B. E. Lenehen
J. T. Lusignan, Jr.
H. Lyons
H. C. Martin
L. W. Matsch
C. E. Melville
J. H. Miller
J. G. Reid, Jr.
R. D. Richardson
J. B. Russell
C. F. Savage
J. P. Scott
F. B. Silsbee
D. B. Sinclair
M. B. Stout
E. L. Tornquist
W. R. Turner
J. M. Vanderleck
L. K. Yerger
D. A. Young
C. J. Zeller

INSTRUMENTS AND MEASUREMENTS SUBCOMMITTEES

1. Subcommittee on Definitions

C. L. Dawes, *chairman*
Arthur B. Craig
H. C. Dickinson
W. N. Goodwin, Jr.
Everett S. Lee
B. E. Lenehan
P. MacGahan
F. B. Silsbee

2. Subcommittee on Electrical Tests on Dielectrics in the Field

F. C. Doble, *chairman*
D. L. Brown
A. L. Brownlee
E. B. Curdts
Chester L. Dawes
E. D. Doyle
W. N. Eddy
I. W. Gross
Everett S. Lee
D. B. Sinclair
G. M. L. Sommerman
L. Wetherill

3. Subcommittee on High-Frequency Measurements

F. J. Gaffney, *chairman*
I. G. Easton
E. P. Felch, Jr.
F. Hamberger, Jr.
G. B. Hoadley
H. Lyons
H. R. Meahl
H. E. Webber
H. A. Wheeler

4. Subcommittee on Marking of Varmeters and Related Instruments

Arthur B. Craig, *chairman*
A. L. Brownlee
A. L. Carvill
E. B. Kipp
Walter G. Knickerbocker
A. E. Knowlton
F. B. Silsbee
H. B. Smith

5. Subcommittee on Master Test Code for Resistance Measurements

F. B. Silsbee, *chairman*
E. D. Doyle
Everett S. Lee
L. W. Matsch
D. B. Sinclair

6. Subcommittee on Master Test Code for Temperature Measurements

L. A. Burckmyer, Jr., *chairman*
P. A. Borden
E. D. Doyle
W. R. Hough
A. K. Joecks
R. D. Richardson
M. D. Ross
S. S. Stack

7. Subcommittee on Revision of AIEE Standard *4* (Measurement of Test Voltage in Dielectric Tests)

J. T. Lusignan, *chairman*
P. L. Bellaschi
A. L. Brownlee
J. S. Carroll
J. J. Clark
J. E. Clem
E. W. Davis
C. M. Foust
H. A. Frey
I. W. Gross
J. H. Hagenguth
W. B. Kouwenhoven
R. S. Lapp
W. W. Lewis
M. Newman
W. C. Sealey
F. B. Silsbee
W. T. Smith
R. W. Sorensen
W. L. Teague
S. W. Zimmerman

8. Subcommittee on Revision of C 39 (Electric Indicating Instruments)

H. C. Koenig, *chairman*
R. D. Hickok, Sr.
E. S. Lee
P. MacGahan
J. H. Miller
C. F. Savage
F. B. Silsbee
J. H. Vanderleck
D. A. Young
C. J. Zeller

9. Subcommittee on Watt-hour Meters

W. G. Knickerbocker, *chairman*
A. L. Brownlee
D. T. Canfield
A. B. Craig
F. C. Holtz
H. C. Koenig
B. E. Lenehan
G. B. M. Robertson (AEIC) ex officio
C. F. Savage
M. B. Stout
E. L. Tornquist
L. K. Yerger

Nucleonics

J. J. Smith, *chairman*, General Electric Company, general engineering and consulting laboratory, Schenectady N.Y.

W. E. Barbour, Jr.
R. C. Bergvall
H. W. Bibber
H. W. Brackney
L. J. Bulliet
L. W. Chubb
J. M. Cork
W. F. Davidson
G. W. Dunlap
J. R. Dunning
I. A. Getting
T. S. Gray
M. M. Hubbard
Harvard Hull
J. A. Hutcheson
E. H. Krieg
H. B. Marvin
B. R. Prentice
Walther Richter
Frederick Seitz
Abe Tilles
J. G. Trump
R. E. Watson
J. T. Wilson

NUCLEONICS SUBCOMMITTEE

1. Nucleonics Instrumentation and Control.
G. W. Dunlap, *chairman*

2. Studies of Nuclear Theory
J. T. Wilson, Jr., *chairman*

3. Isotopic Tracers
W. E. Barbour *chairman*

4. Health Safety and Protection Against Radiation

Therapeutics

E. E. Charlton, *chairman*, General Electric Company, research laboratory, Schenectady 5, N. Y.

F. B. Claussen
H. J. Holmquest
Roy Kegerreis
W. B. Kouwenhoven
L. Marinelli
G. E. Maxim
H. D. Moreland
C. M. Slack
W. R. Smith
L. S. Taylor

General Applications Group

General Applications Co-ordinating Committee

H. C. Coleman, *chairman*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

C. C. Whipple
Elgin B. Robertson

Ex-officio
Chairmen of the five following technical committees in the general applications group

Air Transportation

S. D. Summers, *chairman*, Naval Research Laboratory, Washington 20, D. C.

J. W. Allen
G. W. Almassy
J. H. Blankenbuehler
H. R. Brown
W. C. Bryant
A. E. Corcoran
J. P. Dallas
A. Fisher
D. E. Fritz
C. E. Gagnier
S. H. Hanville, Jr.
W. T. Harding
V. P. Hessler
J. G. Hutton
R. R. Jenner
R. D. Jones
R. J. Lusk
T. J. Martin
C. F. McCabe
R. A. Millermaster
J. D. Miner
C. R. Moore
W. F. Moore
Joseph Nader
O. F. Olsen
W. E. Pakala
H. F. Rempt
C. J. Rife
R. A. Rugge
K. R. Smythe
S. H. Webster
W. W. West
J. A. White

AIR TRANSPORTATION SUBCOMMITTEES

1. Aircraft Electric Rotating Machinery Subcommittee

Scope: This subcommittee was organized in 1944 for the purpose of preparing standard test codes for aircraft electric rotating machinery. As a result, AIEE 800, Proposed Test Code for D-C Aircraft Machines, was published in March 1947 for one year trial use. The subcommittee now is preparing "Rating Standards or Engine-Driven Generators."

D. E. Fritz, *chairman*
J. W. Allen
A. Fisher
S. H. Hanville, Jr.
R. D. Jones
L. R. Larson
A. N. Lawrence
G. W. Sherman
R. R. Smith

2. Aircraft Systems Subcommittee

Scope: The purpose of this subcommittee is to formulate a report on the basic and accepted considerations involved in the application practice of aircraft electrical systems. This report shall contain information of the following character: an explanation of fundamental electrical problems, outlines of systematic procedures for analysis and computation of aircraft electrical system performance, and formulation of general application practices which will assure correct coordination of equipment.

W. F. Moore, *chairman*
J. W. Allen
H. B. Bunce
H. L. Hildebrandt
G. A. Phillips
D. H. Scott
K. R. Smythe
A. J. Snyder
A. F. Trumbull

3. Subcommittee on Basic Principles of Altitude Rating of Electric Apparatus

Scope: This subcommittee will prepare no test codes nor standards for specific apparatus; but rather, it will prepare a report indicating the basic principles of altitude rating of electric apparatus. Such a report will be useful in the preparation of test codes and standards and in the design and testing of aircraft equipment. The first phase of the project will be from sea level to 50,000 feet altitude.

W. E. Pakala, *chairman*
J. W. Allen
T. R. Brown
S. H. Hanville, Jr.
J. G. Hutton
Chester A. Maple
A. T. McClinton
R. A. Rugge

4. Subcommittee on Aircraft Electrical Control Protective Devices, and Cable

Scope: Formation of test codes and operating standards for aircraft electrical control, protective devices, and cable. The subcommittee is engaged presently in the preparation of a test code for aircraft circuit interrupting devices and a test code for aircraft d-c generator voltage regulators is being prepared by a working group of the subcommittee.

R. J. Lusk, *chairman*
B. O. Austin
E. E. Magee
A. T. McClinton
R. A. Millermaster
H. S. Moore
W. F. Moore
J. Ottmar
J. H. Taylor
W. W. West

Domestic and Commercial Applications

M. M. Brandon, *chairman*, Underwriters Laboratories, Inc., 161 Sixth Avenue, New York 13, N. Y.

S. W. Andrews
D. K. Blake
A. C. Bredahl
W. B. Buchanan
O. Kendall Buck
O. K. Coleman
T. H. David, Jr.
L. R. Gamble
R. W. Fleming
T. C. Johnson
R. R. Herrmann
C. H. Leatham
F. W. Linder
B. H. Martin
L. W. McCullough
H. E. Metz
K. W. Miller
A. L. Riche
C. F. Scott
H. P. Seelye
G. S. Smith
G. C. Tenney
Wesley Weinerth

Land Transportation

J. C. Aydelott, *chairman*, General Electric Company locomotive and car equipment divisions, 2901 East Lake Road, Erie, Pa.

L. S. Billau
L. W. Birch
H. R. Blomquist
W. A. Brecht
H. F. Brown
D. M. Burckett
C. N. Chase
W. J. Clardy
Andrew Costic
H. E. Dralle
Llewellyn Evans
J. C. Fox
A. P. Frey
K. H. Gordon
W. S. H. Hamilton
P. H. Hatch
G L. Hoard
J. G. Inglis
R. L. Kimball
S. B. Lent
T. M. C. Martin
P. A. McGee
E. B. Meissner
Ira S. Nippes
A. G. Oehler
J. F. Sellers
W. R. Simmons
Dwight L. Smith
Jacob Stair, Jr.
M. C. Swanson
R. G. Thring
J. P. Tretton
R. S. Warren
R. A. Williamson
H. P. Wright

LAND TRANSPORTATION SUBCOMMITTEES

1. Heavy Traction Electrification Data Subcommittee

Scope: To collect and tabulate data covering power supply, conversion and distribution systems, and motive power of electrified railroads in the United States and to present them in a way to show the extent of existing electrifications and trends as indicated by chronological developments. Since 1933, general information on railway electrification, both domestic and foreign, has not been available principally because of the discontinuance of the collection of these data by the National Electric Light Association and the disbanding of the heavy electric traction committee of the American Transit Association. In January 1947, this subcommittee was formed and the work is divided into five projects.

L. W. Birch, *chairman*
H. F. Brown
W. J. Clardy
F. H. Craton
A. G. Oehler

Projects:

(*1-1*). Catenary overhead systems
(*1-2*). Third rail systems
(*1-3*). Electric locomotives
(*1-4*). Substations
(*1-5*). Power supply

The personnel of the projects is as follows:

(*1-1*) and (*1-2*). { L. W. Birch, *chairman*; H. F. Brown
(*1-3*), (*1-4*), and (*1-5*). { A. G. Oehler; F. H. Craton; W. J. Clardy

2. Heavy Traction Papers and Plans Subcommittee

Scope: To secure papers and discussion for the various AIEE meetings, covering matters of current interest in the field relating to railroad electrification, Diesel-electric locomotives, and all other applications of electricity to railroad rolling stock such as lighting and air conditioning of passenger cars. This is accomplished by correspondence and personal contact with the leading manufacturers of equipment, and the engineering personnel of the major electrified railroads and consulting engineering firms engaged in such projects.

H. F. Brown, *chairman*
A. L. Brecht
R. L. Kimball

3. Light Traction Papers and Plans Subcommittee

Scope: To secure papers and discussion for the various AIEE meetings, covering matters of current interest in the field relating to local transit, that is, subway, streetcar, and trolley coach systems, and applications of electric propulsion equipment to internally powered local transit vehicles.

W. J. Clardy, *chairman*
Harold R. Blomquist
Dwight L. Smith

4. Subcommittee on Revision of AIEE Standard 16 (Electric Railway Control Apparatus) ASA C48 Subcommittee

Scope: To revise AIEE Standard 16 (Electric Railway Control Apparatus) for the purpose of recognizing new processes, correction of errors, and inclusions of certain new functions and devices. These Standards last were revised in 1933. The subcommittee reported at the Montreal meeting June 1947 and is expecting to present a final report soon.

F. H. Craton, *chairman*
W. J. Clardy
W. S. H. Hamilton
J. G. Inglis

Marine Transportation

O. A. Wilde, *chairman*, Sun Shipbuilding and Dry Dock Company, Chester, Pa.
E. C. Alger
W. B. Armstrong
R. A. Beekman
H. C. Coleman
P. J. DuMont
R. W. Erickson
J. B. Feder
A. R. Gatewood
L. M. Goldsmith
P. A. Guise
H. F. Harvey, Jr.
W. E. Jacobsen
J. E. Jones
C. Krommenhock
Clarence Lynn
V. W. Mayer
S. N. Mead
W. H. Reed
E. M. Rothen
L. B. Sinclair
C. W. Souder
E. H. Stivender
G. O. Watson
F. A. Wickel
W. N. Zippler

MARINE TRANSPORTATION SUBCOMMITTEES

1. Power Generation Subcommittee

C. Lynn, *chairman*
W. B. Armstrong
R. A. Beekman
H. C. Coleman
L. M. Goldsmith
W. E. Jacobsen
E. H. Stivender
O. A. Wilde

2. Power Application Subcommittee

L. M. Goldsmith, *chairman*
W. B. Armstrong
H. C. Coleman
R. W. Erickson
W. E. Jacobsen
J. E. Jones
C. Lynn
E. H. Stivender

3. Wires and Cables Subcommittee

W. N Zippler, *chairman*
P. J. Dumont
J. B. Feder
A. R. Gatewood
W. E. Jacobsen
V. W. Mayer
W. H. Reed
F. A. Wicke

4. Switchboards and Control Subcommittee

H. C. Coleman, *chairman*
R. A. Beekman
P. J. Dumont
H. F. Harvey, Jr.
J. E. Jones
C. Krommenhock
L. B. Sinclair
E. H. Stivender

5. Distribution Subcommittee

H. F. Harvey, Jr., *chairman*
W. B. Armstrong
R. W. Erickson
A. R. Gatewood
L. M. Goldsmith
P. A. Guise
V. W. Mayer
F. A. Wickel
W. N. Zippler

6. Fittings and Appliances Subcommittee

J. B. Feder, *chairman*
E. C. Alger
P. J. Dumont
R. W. Erickson
P. A. Guise
H. F. Harvey, Jr.
V. W. Mayer
E. M. Rothen
L. B. Sinclair
O. A. Wilde

7. Communications and Alarm Subcommittee

W. H. Reed, *chairman*
E. C. Alger
J. B. Feder
A. R. Gatewood
C. Krommenhock
S. N. Mead
E. M. Rothen
L. B. Sinclair
C. Souder

8. Navigation Equipment Subcommittee

S. N. Mead, *chairman*
E. C. Alger
P. A. Guise
C. Krommenhock
E. M. Rothen
G. Souder
F. A. Wickel

9. Publicity, Personnel and History Subcommittee

R. A. Beekman, *chairman*
H. F. Harvey, Jr.
W. H. Reed

10. Editing Subcommittee

W. N. Zippler, *chairman*
J. B. Feder
H. F. Harvey, Jr.
W. H. Reed

Production and Application of Light

Harris Reinhardt, *chairman*, Sylvania Electric Products Company, 500 Fifth Avenue, New York 18, N. Y.
J. F. Angier
L. H. Brown
M. J. Dring
Frank Hansen
C. P. Hayes
S. G. Hibben
O. W. Holden
E. A. Linsday
H. E. Mahan
J. A. McDermott
F. H. Murphy
R. L. Oetting
R. C. Putnam
D. W. Rowton
E. H. Salter
R. G. Slauer
E. M. Strong
H. F. Wall
E. S. West
C. C. Whipple

PRODUCTION AND APPLICATION OF LIGHT SUBCOMMITTEES

1. Ultraviolet Radiations Subcommittee

Scope: The initial scope will be to sponsor the preparation of a report on modern ultraviolet sources. The group also would serve as a clearing house for all information relating to its specific field, and will help in planning convention papers and securing speakers on this subject.

Allen J. Dusault, *chairman*

2. Nomenclature of Electronic Lamps Subcommittee

Scope: This subcommittee was formed for the purpose of co-operating with the subcommittee on electronic standards of the committee on electronics in the preparation of a system of definitions of electronic devices used as light sources. In this connection, light sources is taken as including sources of infrared, visible, and ultraviolet radiations.

E. H. Salter, *chairman*
E. W. Beggs
L. R. Keifler
R. C. Putnam
T. C. Sargent

3. Infrared Radiations Subcommittee

E. A. Linsday, *chairman*

Joint Subcommittees

Joint Subcommittee on Application of Probability Methods to Capacity Problems (Joint with Power Generation and System Engineering Committees)

G. Calabrese, *chairman*
W. R. Blakeley
H. Duryea
R. G. Hooke
H. A. Lott
W. J. Lyman
K. W. Miller
H. W. Phillips
C. A. Roberts
H. B. Smith
H. P. St. Clair
V. A. Thiemann
C. W. Watchorn

Joint Subcommittee on Carbon Brushes (Joint with Rotating Machinery and Air Transportation Committees)

V. P. Hessler, *chairman*
W. H. Austry
H. R. Brown
J. V. Dobson
H. M. Elsey
C. J. Herman
L. H. Hilderbrandt
H. E. Keneipp
E. A. Lapham
T. M. Linville
D. Ramadanoff
Orrin Rutledge
S. D. Summers
Atten: A. L. Van Emdon (Navy Department)

Joint Subcommittee on Standard Frequency Bands and Designations

Scope: To consult with various interested groups and recommend designated bands which conform, as closely as possible, with the desires and needs of the majority. A logarithmic system of bands seems to be indicated to break up this enormous range from a small fraction of a cycle per second to 10^{10} cycles per second or higher into bands which can be designated readily.

Thomas Spooner, *chairman* (representative, electronic standards subcommittee)
C. T. Burke (representative, instruments and measurements committee)
G. B. Ransom (representative, communication committee)
F. B. Silsbee (representative, ASA sectional committee *C68*)
J. E. McCormack (representing ASA Electric Light and Power Group)

Joint Subcommittee on Nucleonic Instruments (Joint with Nucleonics and Instruments and Measurements Committees)

Scope: Treatment of all matters pertaining to the design, construction, and application of devices used for the detection and measurement of nucleonic radiations. The activity of the subcommittee in this field will include:

1. Sponsorship of papers of two general kinds, namely, survey papers of a broad educational nature and descriptive papers covering developments primarily of interest to the membership.

2. Sponsorship of conference sessions on similar subjects.

3. Co-operation with the various existing committees of the AIEE and other organizations, particularly with respect to standardization and definitions. (In this latter instance, it is believed this subcommittee's efforts initially will be by way of review and suggestion.)

G. W. Dunlap, *chairman*
E. E. Goodale, *secretary*
William E. Barbour, Jr.
L. F. Curtiss
F. J. Gaffney
W. H. Hall
M. M. Hubbard
J. A. Hutcheson
P. S. Johnson
J. B. H. Kuper
Frank D. Lewis
G. A. Morton
H. W. Newson
M. A. Schultz
H. G. Weiss

Joint Subcommittee on Electronic Instruments (Join with Electronics and Instruments and Measurements)

J. G. Reid, Jr., *chairman*
Rudolf Feldt, *vice-chairman*
W. H. Tidd
H. W. Berry
L. T. Bourland
C. T. Burke
C. C. Chambers
W. R. Clark
H. F. Dart
H. C. Drake
G. V. Eltgroth
D. B. Fisk
W. A. Geohegan
E. R. Haberland
G. B. Hoadley
Eric Isbister
G. N. Mahafley
C. W. Martel
H. R. Meahl
David Packard
T. B. Perkins
J. J. Slattery
E. R. Thomas
J. T. Thwaites
V. Ulrich
A. H. Waynick
A. J. Williams, Jr.
W. P. Wills

Present Activities:

1. Continuing a program of survey, information collation, and liaison among instrument manufacturers, tube manufacturers, and other groups interested in improving the performance of electron tubes in instrument and industrial applications.

2. To solicit, review, and sponsor technical papers and reports on electronic instruments.

Proposed Future Activities:

1. In the field of electronic instrumentation, an investigation of desirable characteristics for special purpose electron tubes (photoelectric tubes, cathode ray tubes, and so forth).

2. Investigation of desirable characteristics for circuit components to be used in instruments in conjunction with electron tubes (sockets, potentiometers, and so forth).

3. Investigation of the need for definitions and standards pertaining to electronic instruments.

Joint Subcommittee on Telemetering (Joint with Substation and Instruments and Measurements Committee)

Scope: Telemetering is assigned primarily to the committee on instruments and measurements and handled by a joint subcommittee comprised of members of both the committees on substations and on instruments and measurements. Telemetering problems in connection with automatic stations will be assigned by the chairman of the committee on instruments and measurements to members of the subcommittee who are also members of the substation committee. Telemetering problems of a more general nature will be assigned by him to members of both main committees and where the problem is simply measurements it will be assigned only to members of the committee on instruments and measurements.

Substation Appointees:
W. A. Derr
W. L. Hiscox, *secretary*
George S. Lunge
A. P. Peterson
M. Robison (representative, carrier current committee)
J. H. Vivian
C. E. Winegartner

Instruments and Measurements Appointees:
C. K. Duff, *chairman*
P. A. Borden
M. A. Bostwick
E. C. Brown
J. T. Logan
E. E. Lynch
W. E. Phillips
G. M. Thynell

Report of the Board of Directors

THE BOARD OF DIRECTORS of the American Institute of Electrical Engineers presents herewith to the membership its 64th annual report, for the fiscal year ending April 30, 1948. It includes a general balance sheet and other statements showing the financial condition of the Institute at the close of the fiscal year and a brief summary of the principal activities of the Institute during the year, more detailed information having been published from month to month in *ELECTRICAL ENGINEERING*.

BOARD OF DIRECTORS' MEETINGS

Five meetings of the board of directors were held during the year, two in New York, N. Y., one in Montreal, Quebec, Canada, one in Chicago, Ill., and one in Pittsburgh, Pa.

Information regarding many of the more important activities of the Institute which have been under consideration by the board of directors and AIEE committees is published each month in the section of *ELECTRICAL ENGINEERING* devoted to Institute activities.

PLACES VISITED BY PRESIDENT HULL

California
Pacific general meeting, San Diego; Los Angeles Section; San Francisco Section

Colorado
Denver Section

Connecticut
North Eastern District meeting, New Haven

District of Columbia
Washington Section; George Washington University Branch, Catholic University of America Branch, Washington

Illinois
Midwest general meeting, Chicago; Illinois Valley Section, Peoria; Urbana Section

Iowa
Great Lakes District meeting, Des Moines

Kansas
Wichita Section

Louisiana
New Orleans Section; Shreveport Section

Maryland
Maryland Section, Baltimore; University of Maryland Branch, College Park

Mexico
Summer general meeting, Mexico, Federal District

Minnesota
Minnesota Section, St. Paul

Missouri
Kansas City Section; St. Louis Section

Montana
Montana Section, Butte

Nebraska
Nebraska Section, Omaha

New York
Meetings of board of directors, Engineers Joint Council, conferences, New York, N. Y.

Ohio
Middle Eastern District meeting, Dayton; Cincinnati Section; Cleveland Section; Columbus Section; Toledo Section

Oklahoma
South West District executive committee meeting, Oklahoma City

Oregon
Portland Section

Pennsylvania
Winter general meeting, Pittsburgh; Philadelphia Section

Texas
North Texas Section, Dallas

Utah
Utah Section, Salt Lake City

Washington
Seattle Section; Spokane Section

Wisconsin
Madison Section

ANNUAL MEETING

The annual business meeting of the Institute was held on June 11, 1947, in Montreal, Quebec, Canada. The annual report of the board of directors for the fiscal year which ended April 30, 1947, was presented in abstract by Secretary H. H. Henline, and the Institute's financial situation was reviewed by Treasurer W. I. Slichter. The report of the committee of tellers on the election of officers for the year which began on August 1, 1947, was presented, and President-Elect Blake D. Hull responded to his introduction with a brief address. National prizes for papers were presented.

The Lamme Medal for 1946 was presented to John B. MacNeill, manager of the switchgear and control division, Westinghouse Electric Corporation. The president's address by J. Elmer Housley concluded the meeting.

GENERAL MEETINGS

A brief report on each of the four general meetings held during the year follows:

Summer General Meeting. The 63d summer general meeting was held in Montreal, Quebec, Canada, June 9–13, 1947, with a registration of 1,451. The program included 13 regular technical sessions, 14 conference sessions, 10 administrative conferences, and about 25 committee meetings, in addition to the afore-mentioned annual business meeting. There were entertainment events, inspection trips, golf tournaments, a president's reception, a banquet, and a dance.

Pacific General Meeting. The Pacific general meeting was held in San Diego, Calif., August 26–29, 1947, with a registration of 589, a new attendance record for the meeting. There were 15 sessions, including two devoted to the presentation of student papers, a luncheon with address by President Hull, Student Branch conference and a conference of District and Section officers, inspection trips, a golf tournament, and numerous social and entertainment activities including a "Night in Old Mexico," with dinner at Serena's in Tijuana.

Midwest General Meeting. The first Midwest general meeting was held in Chicago, Ill., November 3–7, 1947, with a registration of 1,449. This meeting is to be held annually in the "Middle West." The Chicago meeting included three general sessions, seven technical sessions, and nine technical conference sessions, including one held jointly with the National Electronics Conference. About 40 meetings of general and technical committees were held. The program included a dinner-smoker with entertainment, many inspection trips, and numerous events for the women.

Winter General Meeting. The winter general meeting was held in Pittsburgh, Pa., January 26–30, 1948. The registration was 3,081. A total of 51 technical sessions included 18 for formally approved papers, 18 for informal conference papers, and 15 at which both types of papers were presented. Meetings were held by about 75 technical and general committees. The Edison Medal for 1947 was presented to Doctor Joseph Slepian. Other features were a smoker, a dinner-dance, many inspection trips, and a generous program of social and entertainment events for the women.

DISTRICT MEETINGS

Middle Eastern District Meeting. The first Middle Eastern District meeting since 1940 was held in Dayton, Ohio, September 23–25, 1947. The registration was 502. There were eight technical sessions and one general session. Papers presented included 28 formally approved and 12 conference papers. The program also included a banquet, inspection trips, and special features for the women. The District executive committee held an all-day meeting on September 22.

Great Lakes District Meeting. The eighth Great Lakes District meeting was held in Des Moines, Iowa, April 1–3, 1948, with a registration of 357. Seven technical sessions provided for the presentation of 13 formal papers, 8 conference papers, and 10 undergraduate and 7 graduate student papers. President Hull gave the principal address in the opening session on the subject "Ceiling Unlimited." There were several inspection trips, a banquet, a general luncheon, and numerous events for the women.

North Eastern District Meeting. This meeting was held in New Haven, Conn., April 28–30, 1948, with a registration of 669. The technical program included 17 formally approved papers, 27 District papers, and 11 student papers. There was a general session with four addresses. Other events were a District executive committee luncheon, a dinner, inspection trip, and various events for the women.

TECHNICAL CONFERENCES

A conference on electron tubes held in Philadelphia, Pa., March 29–30, 1948, and a conference on electrical problems in the rubber and plastics industries held in Akron, Ohio, April 20, 1948, introduced a new activity devoted to more extensive consideration of specialized technical subjects. The first was sponsored by the joint subcommittee on electron instruments of the committees on electronics and instruments and measurements, with the co-operation of the Philadelphia Section. The second was sponsored by the subcommittee on rubber and plastics of the committee on general industry applications and the Akron Section.

General Committees

FINANCE COMMITTEE

As seemed inevitable from recent trends, the fiscal year ending on April 30, 1948, showed a substantial operating deficit.

While we had a $75,500 (almost 14 per cent) increase in income, our expenditures increased $144,000 (or 27 per cent), resulting in a deficit of approximately $44,500. This deficit was met by withdrawal from our reserve capital funds.

For the budget year October 1, 1947, through September 30, 1948, the board of directors adopted a budget which, in spite of efforts to hold appropriations to a minimum consistent with the vigorous and progressive activities of the Institute, showed a deficit of some $23,000. This was after taking full account of the anticipated growth in membership and the substantial increase in advertising revenues expected to result from higher advertising rates and more active advertising sales effort. Subsequent experience has indicated that costs will be even higher than budgeted without corresponding increases in revenue, so that the budget year deficit is expected to somewhat exceed the original budget estimate but should not be in excess of the $44,500 operating loss for the fiscal year just ended.

Because these trends raise the obvious question as to whether continually increasing costs per member can be met without increasing payments per member, President Hull appointed a special committee to study the whole matter and recommend a course of action. Fortunately, we have a capital reserve fund that is adequate to tide us over any deficits that can be anticipated for the immediate future unless there should be a sharp recession with resultant drop in revenues from membership dues and advertising.

COMMITTEE ON PLANNING AND CO-ORDINATION

Further work has been done toward implementing the Institute's technical activities as reorganized last year and as outlined in the memorandum by Doctor Wickenden.

The four co-ordinating committees of the technical committees each have served, as the name implies, to harmonize and advance the activities of their respective technical committees. Committee scopes, membership lists, and agenda have been correlated and new work initiated. The co-ordinating committees warranted more formal status by defining certain general items of their scopes and this has been done by the committee.

A technical activities subcommittee was continued, the membership this administrative year consisting of the chairmen of the four co-ordinating committees. The purpose of this subcommittee was to correlate the activities of the co-ordinating committees, to keep the committee on planning and co-ordination informed as to progress being made in the co-ordination of the various technical activities of the Institute, and to serve as a medium of co-ordination on a national and on a Sections basis. This technical activities subcommittee has aided in eliminating duplication of technical effort by the Institute's technical committees with those of other organizations. It is clearly evident that the co-ordinating committee setup is working out admirably well. The committee recently has decided to augment the personnel of the technical activities subcommittee to include the vice-chairmen, as well as the chairmen, of the four co-ordinating committees, and also the chairman and vice-chairman each of the technical program and Standards committees.

There have been two groups in the Institute's organizational setup, one known as the administrative group and one as the professional group. The administrative group is not now serving any particular need, and the committee has recommended and the board of directors approved the discontinuance of this group at the end of the present administrative year.

The new scopes of the power group committees were endorsed and recommended to the board of directors for approval. Changes in names of certain committees in the industrial and power groups were considered and approved. The formulation of a new committee on computing devices also was approved together with suitable scope. The scope for the new committee on management was reaffirmed.

The committee has considered the invitations received and recommended to the board of directors specific locations and dates for future national and District meetings for the next three years. It is necessary that these be determined well in advance of the scheduled dates so that suitable arrangements can be made.

A new type of meeting recently has been conceived known as the "technical committee conference." This may be defined as a program of panel discussions, technical papers, or exhibits under the auspices of a national technical committee, or subcommittee. The purpose of these meetings is to expand technical committee activities on individual specialized subjects and to serve the interests of members and nonmembers on that subject. Two of these technical conferences have been held to date: one on the subject of electron tubes at Philadelphia during March and one on rubber and plastics in Akron during April. It has been reported that these conferences were extremely successful and the committee believes every encouragement should be given them.

A recommended policy for these technical committee conferences was established. This includes definition, scope, financial arrangement, and authorization for such conferences. The authorization is to be in the hands of the chairman of the co-ordinating committee affected and he will correlate with the technical program committee and others. The board of directors will need to be consulted only when financing is involved.

The subject of Institute prize awards is being restudied in detail. A subcommittee of the Sections committee has undertaken this work and a report with recommendations is expected later this year.

Work has been initiated covering the establishment of a publicity policy for the Institute. A statement of policy prepared by the committee on publicity has been approved by the committee on planning and co-ordination and by the board of directors.

There has been considerable discussion regarding the need for and the procedure to be followed in "Organization of the Engineering Profession." The committee has recommended and the board of directors has approved the following resolution:

RESOLVED:

1. That the resolution adopted by the board of directors at its meeting on November 5, 1947, be reaffirmed and that the board express its desire for prompt action.

2. That the board (of directors) ask its representatives of the EJC (Engineers Joint Council) to request very prompt action be taken on this matter.

3. That the board (of directors) authorize President Hull, and representatives designated by him, to accept invitations from the boards (of directors) of other national engineering societies to present the views of the AIEE.

Numerous proposed modifications of the Institute's constitution and bylaws have been reviewed and discussed. Certain changes have been approved for submission to the board of directors.

The Italy America Society, Inc., has offered the Institute certain funds, and suitable plans are to be developed for the administration of such funds if they become available.

PUBLICATION COMMITTEE

The new publication policy, which went into effect January 1, 1947, now has been in effect for 16 months, and in general is functioning successfully and satisfactorily according to plan. The full details of the new program were explained to the membership by the then chairman, C. F. Wagner, of the publication committee, in an article (*EE, Dec '46, pp 576–8*); and the essential substance of these same details were embraced in the 1947 report of the publication committee to the board of directors. A few necessary modifications and minor adjustments of details have been made according to the requirements of the circumstances as the new procedures have been developed and applied.

The plan provided for three basic correlated publications, *ELECTRICAL ENGINEERING*, *TRANSACTIONS*, and *PROCEEDINGS*. This program seems to be meeting very well the broad and diverse interests of the membership, according to questionnaires which were circulated at the 1947 summer general meeting and at the 1947 Pacific general meeting, and also as indicated by informal comments and discussions at other meetings and by correspondence received from individual members.

In summary, the highlights of the publication year are: the improvement in the physical appearance of *ELECTRICAL ENGINEERING*, the increase in the advertising content, and the improved scope and subject balance of the text material published; the adoption of a flat price for the advance pamphlet copies of technical program papers, regardless of the number of pages of the pamphlet, in place of the previous and more complicated sliding-scale price schedule; the successful initiation of the new interim publication service to the Institute members represented by the newly re-established *PROCEEDINGS*, and the related and surprising discovery that the actual membership demand for *PROCEEDINGS* is materially lower than initially was contemplated; the postponement of publication of the 1948 "Year Book" for the purpose of establishing a new and more effective publication cycle coordinated with the administrative year, which begins the first of August.

ELECTRICAL ENGINEERING. *ELECTRICAL ENGINEERING* continues as the general service publication which reaches all members, all Student members, and a substantial list of nonmember subscribers. With the release of previous space commitments for *TRANSACTIONS* pages in *ELECTRICAL ENGINEERING*, the scope and nature of subject matter published in the monthly has been, and still is being, progres-

Table I. Numbers of Pages of Published Material

Year	*ELECTRICAL ENGINEERING* General Interest Articles	*ELECTRICAL ENGINEERING* News	*ELECTRICAL ENGINEERING* Transactions Section	*TRANSACTIONS* Only Technical Papers	*TRANSACTIONS* Only Discussions	Totals
1941	337	281	600	542	268	2,028
1944	246	214	738	493	231	1,922
1945	255	225	736	121	143	1,480
1946	285	315	832	254	120	1,806
1947	806	474		1,463*	153*	2,896*

* Preprinted in 227 sections of AIEE *PROCEEDINGS*, except for a 17-page technical paper in *ELECTRICAL ENGINEERING.*

sively broadened to serve better the diversified interests of the membership and to supplement the complete formal technical papers published in *PROCEEDINGS* and *TRANSACTIONS.* Direct contact with these formal papers has been maintained for all readers of *ELECTRICAL ENGINEERING*, however, by virtue of the fact that either the full text or essential substance of a large number of technical papers has been published in *ELECTRICAL ENGINEERING* and at least a brief abstract of all the other *TRANSACTIONS* papers has been published. A significant change and further improvement in this service has been made and is taking effect as this report is issued in June, in that the previous very short abstract, often merely descriptive of the paper rather than revealing its subject matter, has been developed into a digest article, each of which with one or two illustrations will comprise units of approximately one page in *ELECTRICAL ENGINEERING.* Thus, every reader is assured of receiving at least the essential substance of every technical program paper.

The physical appearance of *ELECTRICAL ENGINEERING* was improved beginning with the September 1947 issue by a change to white paper of better quality, and a further change was made in the finish of the new paper to improve the quality of printing, effective with the April 1948 issue. In general, the paper supply situation has eased to a point where, with the close co-operation of suppliers, it has been possible to meet the steadily growing requirements for *ELECTRICAL ENGINEERING* paper. Severe production delays and other related difficulties incidental to protracted printing congestion have continued, with resulting tardiness in the issuance of the monthly edition. This has been annoying to readers and to advertisers, and has compounded the production difficulties of the editorial staff. As this report is issued, however, substantial improvement is being made at long last in the printing schedule, and it seems reasonable to hope that *ELECTRICAL ENGINEERING*'s mailing schedule of the 22d of the month preceding the date of issue can be re-established with the May 1948 issue.

ELECTRICAL ENGINEERING's circulation of the April 1948 issue was 45,000, one of the highest in the whole field of technical and professional journals. The steady growth of this circulation during recent years is indicated in the following:

January 1948	43,000
January 1947	36,300
January 1946	29,000
January 1945	26,450
January 1944	25,000
January 1943	24,900
January 1942	24,800
January 1941	23,900
January 1940	23,000
January 1935	18,500

The number of pages of published material for a few years back is shown in Table I, and there is a very large increase in 1947. This increase is a reflection, to a degree, of the additional number of general meetings, and of the effort to supply the readers' demands.

Advertising. Advertising policies and procedures have been given special attention by the publication committee and by the board of directors during the year. A more active advertising program was adopted, a new advertising director joined the publication staff at headquarters, advertising field representatives located in Chicago were engaged to service the Middle West territory, and advertising space rates approximately were doubled to bring them to a level more nearly commensurate with *ELECTRICAL ENGINEERING*'s production costs and high level of circulation. Also, advertising agency commissions were established, in accordance with prevailing trade practice. The resultant effect of these changes, while not fully felt to date, was to arrest the definite and alarming downward trend in advertising revenue, and actually did produce an increase in 1947–48 over 1946–47. Further effect is expected in 1948–49.

An interesting and useful 4-page pamphlet was prepared, entitled, "Industry Depends on the Electrical Engineer," which shows the geographical paid distribution and occupational analysis of readers for 1947 for 40,847 circulation of *ELECTRICAL ENGINEERING.* These data will be of great use and help in our advertising campaign.

PROCEEDINGS. Under the new publication program, the *PROCEEDINGS* was established expressly for the purpose of providing a special interim service for those members especially interested in the early availability of the full and complete technical and mathematical details of subject matter within the fields of their particular professional interests, including the discussions of the papers presented. In effect, the *PROCEEDINGS* is a preprint service from the annual *TRANSACTIONS* through which members may receive *TRANSACTIONS* papers and discussions many months ahead of their best possible availability in the *TRANSACTIONS* volumes. The *PROCEEDINGS* sections are made available to the membership through the medium of order forms which are published from time to time in *ELECTRICAL ENGINEERING* as the material covered is about to become available for distribution. The 1947 *TRANSACTIONS* papers were serviced by order forms published in the February, June, and December 1947 issues of *ELECTRICAL ENGINEERING*, and the first year's experience indicates that about 2,000 members are availing themselves of this *PROCEEDINGS* service. In brief, the governing policy is that single copies of *PROCEEDINGS* sections may be obtained by any member through the use of the order form, up to ten per cent of the items on any order form free and additional items at a flat subsidized price of ten cents each if remittance accompanies the order; Student members may procure desired *PROCEEDINGS* sections at ten cents each through the use of the order form. So far as it has been possible to determine, this is a pioneer effort in such selective distribution of diversified publications. It is working out quite closely in accordance with expectations, except that the quantity requirements are substantially lower than were contemplated. Except for the production and distribution delays resulting from printing congestion, which have been quite severe, the membership reaction to this specialized service has been strongly favorable.

As the first year of this service came to a close, the printing-production delays were being substantially overcome, with the result that a corresponding reduction has been possible in the time delay between receipt of a member's order form and the mailing of the requested *PROCEEDINGS.* However, there is a minimum delay below which it is impossible to go. This minimum delay is dictated by two factors: first, the fact that the final processing of a technical paper manuscript cannot even be started until about a month after the date of a meeting at which the paper is presented, when the meeting discussion on that paper becomes available; second, the fact that in the interests of production economy it is necessary to equalize over a 12-month period the peak load influxes of new material related to the various District and general meetings.

In accordance with the action taken by the board of directors at its November 1947 meeting, the general governing policy has been established that the primary objective of the *PROCEEDINGS* is the immediate distribution of requested technical material in minimum possible time after publication of an order form in *ELECTRICAL ENGINEERING;* that such order forms will be honored subsequently within the limits of available printed stock of *PROCEEDINGS;* that no effort will be made to maintain stocks of *PROCEEDINGS* available for distribution after the issuance of the *TRANSACTIONS* volume containing the material from those *PROCEEDINGS.*

Preprints. The practice of issuing technical program papers in pamphlet form (preprints) in advance of the meetings for which they are scheduled is being continued in line with the general publication policy. Some changes in procedural details have been made, however, in line with the recommendations of the finance committee as embraced in the budget action of the board of directors at its November 1947 meeting: first, free distribution is limited to a maximum of five copies of a paper to go to each author, and not to exceed ten copies of each paper to be available to the sponsoring technical committee expressly for the purpose of inviting and stimulating specific discussions; second, the establishment of a flat member price of 30 cents per copy (nonmembers 60 cents) regardless of the number of pages and regardless of whether procured by mail or personally at headquarters or meetings; third, the provision that authors or the companies with which they are affiliated may procure, by written order submitted with the final draft of the manuscript, nominal quantities at the individual member price of 30 cents per copy in advance of the meetings, leaving large quantity orders to be serviced and quoted upon separately by headquarters after the initial requirements for the meeting have been satisfied. This latter restriction was essential to reduce and avoid critical premeeting congestion in the printing and distribution of this material.

Special Publications. Several special publications were produced during the year and made available for sale in accordance with announcements carried in *ELECTRICAL ENGINEERING*. These include:

1. "Application of Electric Conversion Equipment to the Electrochemical Industry"
2. "Bibliography on High-Frequency Dielectric Heating"
3. "Electric Power Applications in the Textile Industry"
4. "Electric Power in the Pulp and Paper Industry"
5. "Statistical Methods in Quality Control"
6. "Tidd 500-Kv Test Lines"
7. "Report on Electron Tube Survey of Instrument Manufacturers and Laboratories"

Year Book. Effective with the 1948 edition, the "Year Book" will be published and distributed in the early fall, probably during September, instead of early in the spring as it has been in recent years. The objective of this change is to make available at the beginning of the AIEE administrative year, an up-to-date roster that will be of maximum service to the new officer and committee personnel and other members. This change was recommended by the publication committee on the basis of a questionnaire survey, and approved by the board of directors at its January 1948 meeting.

The 1948 "Year Book" also will include the 1947–48 officers, so that there will be no break in the publishing of these lists.

Administrative. In addition to the very heavy production load picked up by the editorial staff incidental to the activation of the enlarged publication program in 1947, there was the attendant difficulty of procuring and retaining the necessary qualified personnel. Typical of prevailing economic and industrial conditions, the turnover in editorial personnel for the year was exceedingly high, the equivalent of 100 per cent staff turnover in terms of the number of persons involved, and the losses in training and production time. This condition seriously impeded operations and materially reduced production efficiency. However, toward the close of the fiscal year covered by this report, appreciable improvement had been accomplished and the situation seemed to be approaching a degree of reasonable stability in terms of qualified personnel, and the substantial assistance of the finance committee and the board of directors toward the accomplishment of this condition hereby is appreciated and acknowledged.

Costs. The cost of publishing *ELECTRICAL ENGINEERING* and associated printed matter materially has increased. This is due to a number of factors, among which are

1. Paper cost.
2. Printing cost.
3. Additional pages in *ELECTRICAL ENGINEERING*, additional preprints, and additional *PROCEEDINGS* as a result of a third general meeting.
4. Editorial staff payroll increases.
5. Increased circulation.

Of course, there are a number of revenue increases to compensate to some extent for these cost increases, and among these are increased advertising rates, increased charges for preprints, and so forth.

SECTIONS COMMITTEE

1. Section Activities. Section activities have continued at accelerated postwar levels, as indicated in the following:

New Sections organized

Arkansas
Arrowhead, Minn.
Canton, Ohio
Panhandle Plains, Tex.
Rock River Valley, Ill.
Shreveport, La.

New Subsections organized

Binghamton Area, N. Y.
Corpus Christi, Tex.
Fox River Valley, Wis.
Freeport, Tex.
Johnstown, Pa.
Little Falls, Minn.
Quad Cities, Iowa
Red River Valley, Minn.
St. Maurice Valley, Quebec, Canada
San Jose, Calif.
San Juan, Puerto Rico
Shasta, Calif.
West Central Texas
Western Virginia

The Sections committee actively has encouraged aggressive Section programs and has cosponsored Section membership promotion meetings.

The booklet "Section Activities," prepared by last year's Sections committee, has been circulated to Section officers and all other interested Institute officers and committeemen. This excellent work covers all essential Section activities.

Table II. Section and Branch Statistics

	For Fiscal Year Ending April 30					
	1943	1944	1945	1946	1947	1948
Sections						
Number of Sections	73	73	73	75	75	81
Number of meetings held	598	738	884	1,210	1,333	1,340
Total attendance	66,111	83,120	96,346	113,531	155,649	109,637
Branches						
Number of Branches	125	125	125	125	126	127
Number of meetings held	942	755	547	716	1,018	1,172
Total attendance	38,227	24,768	17,132	22,844	40,669	77,040

During the current season, an outline of model Section activities has been perfected under the direction of Fischer Black, Sections committee member from the Washington Section. This will assist materially new Section officers as a guide and check sheet for each item of successful Section operations. This outline will be presented in its final form at the Sections committee meeting in Mexico City.

2. Bylaws Changes. Several amendments to the Institute bylaws have been recommended by this year's Sections committee. One of these formalizes the recognition of Subsections and Section Divisions; another, increases from 25 to 50 the number of members required on a petition for Section status. This recommendation is based on the fact that practically all Sections authorized within recent years have developed from Subsections or Section Divisions and the fact that it is not economically sound to have Sections of the Institute with less than 50 members.

Another recommendation for a change in bylaws proposes that any Section having less than 30 members or holding less than four meetings during a fiscal year will be changed to a Subsection at the end of the following year if during the interim period sufficient activity has not been exhibited to conform with the foregoing requirements.

3. Subcommittees on Prize Paper Rules and Section Finances. A subcommittee of the Sections committee, under the chairmanship of Fischer Black, has been appointed to study and make recommendations for changes in the Institute prize paper rules. This subcommittee is expected to report at the meeting of the Sections committee in Mexico City.

Another subcommittee of the Sections committee, under the chairmanship of Victor Siegfried of the Worcester Section, has been appointed to study the subject of "Section Finances." This committee likewise will report at the Mexico City meeting.

4. Section Committee Meetings. The Sections committee held a meeting in Pittsburgh on January 28, 1948, with 55 members and guests in attendance. Actions at this meeting included recommendations to the board of directors for the assignment of Alaska to the Seattle Section and District number 9, in addition to the recommended changes in bylaws and other actions mentioned in other parts of this report.

The Sections committee will conduct a conference on Section operation and management, and a delegates' get-together during the summer general meeting in Mexico City.

5. Co-operation With Other Institute Committees. The Sections committee has maintained active co-operation with the Institute committees on membership transfers, Student Branches, and technical program, the industry co-ordinating committee, the general industry applications committee, the industrial power system subcommittee, and to a lesser degree many other working committees of the Institute.

COMMITTEE ON RESEARCH

The principal activity of the committee during the past year was the sponsoring of a symposium on new materials at the winter general meeting. A total of 14 papers was presented, principally in the fields of magnetic materials, dielectrics, insulations, and semiconductors.

The papers brought out a considerable amount of new information which may influence future trends in electrical engineering practice to a significant degree.

A summary of the properties of the materials discussed also was prepared for the proceedings to make the significant parts of the information readily available.

Proposed papers for the summer general meeting were reviewed.

A former activity of this committee, namely, the listing of suggested research projects for which it is deemed there is considerable need is again under consideration by the committee as a possible future activity.

STANDARDS COMMITTEE

During the early months of the year 1947–48, the Standards committee approved a large number of Standards and codes, some of which had been in course of development for long periods, because of wartime activity demands on the time of many of those making up the originating committees. Since the June 1947 meeting, a large part of the committee's time has been devoted to the reorganization and reactivation of committees whose personnel had been affected by changes in member business affiliations following the war.

One of the projects on which formal approval was obtained, was the report of the special committee on sign of reactive power under R. C. Bergvall, as chairman. For years this question has been the subject of controversy among the various interested groups. After a careful study of all the factors involved, a utilization of all available publicity in obtaining criticisms and suggestions, formal action reversing the present AIEE Standards was taken, that is, a change of the sign of reactive power from minus to plus.

The subcommittee on applications of statistical methods to quality control, under Chairman Dobson, having arranged for the presentation and publication of 11 papers on that subject, now is negotiating with the American Society for Quality Control, for the obtaining of additional papers on application in the electrical field as well as the institution of an educational campaign toward the wider application of quality control.

The prospect for future Standards activities seems to have been enhanced by the recent enlargement of the Institute technical committee structure. The greatly increased number of technical committees certainly should result in greater interest and activity in each individual field. A resumption of activity in the International Standards field also can be expected, due to the recent organization of the International Organization for Standardization. The United States National Committee of the IEC, while inactive during the war, again will take over the handling of the American phase of the ISO work. With relation to this international phase of Standards work, attention is called to the successful international session held under the auspices of the Standards committee in Montreal on June 10, 1947, and the proposed session in Mexico City during the summer general meeting.

The work on aeronautical electrical Standards is going ahead with the active cooperation of the technical committee on air transportation under S. D. Summers, chairman. Direct contact now has been made with the chairman of the National Aeronautical Standards Committee, which it is hoped will lead to a closer contact than has been had in the past with those interested in the furtherance of such standardization.

During the past year the following Standards and codes have been approved by the Standards committee: General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Apparatus (a revision); Electric Recording Instruments; Neutral Grounding Devices (a revision); Aircraft D-C Apparatus Voltage Ratings; Master Test Code for Resistance Measurements (a report); Letter Symbols for Physics; Potheads; Roof, Floor and Wall Bushings; Graphical Symbols and Abbreviations for Use on Drawings; Graphical Symbols for Electron Devices.

The sectional committee on definitions of electrical terms, for which the Institute is sponsor, a major AIEE project, inactive during the war, now has been reorganized completely under the chairmanship of Professor Dawes. The work of its 18 subcommittees is now well under way.

In a move to expedite both the approval of Standards and codes, and the appointment of AIEE representatives on various standardizing committees, Chairman Jones made an appeal to the board of directors for the delegation to the Standards committee of the power to give such approval in the name of the Institute. The board of directors approved his request on April 23, 1948.

TECHNICAL PROGRAM COMMITTEE

Technical Programs. The technical programs for the general meetings and District meetings have been kept on a high standard and at the same time enlarged to correspond to the growth in Institute membership. In Table III, the number of papers presented at each of the seven meetings which were held during the year are given, together with the attendance. The total of 233 *TRANSACTIONS* papers and 30 advance copy papers approaches closely the 270 average estimated number of papers a year for the five year period following 1945 presented in the 62d annual report of the board of directors for the fiscal year ending April 30, 1946.

Planning for Programs. In the arrangement of programs, an attempt has been made to cover all new developments in the field of electrical engineering and the allied arts. The geographical location of meetings also has been taken into consideration, and papers have been presented which were of particular interest in certain regions. For the summer general meeting in Montreal, sessions were held on power supply in paper mills and hydroelectric power generation. For the Pacific general meeting in San Diego, an important symposium on sonar was held as well as two sessions on aircraft. For the Middle Eastern District meeting in Dayton, the home of Wright Field and the heart of small motor manufacture, it was only natural that the program was devoted to electrical applications to aircraft and the design and performance of small motors. For the winter general meeting in Pittsburgh, a number of sessions were held which dealt with electrical applications to the production of iron and steel as well as mining.

Analysis of Subject Matter. In the field of power, two important symposiums on the Tidd 500-kv test lines were presented at the Midwest general meeting. The papers described the apparatus, line conductors, insulators, and hardware design for these test lines, and the resulting data will be of value in designing higher voltage transmission lines. In the field of communication, sessions on frequency and pulse modulation, sonar, and synthetic crystals were outstanding. In the industrial field, sessions on applications to the steel industry and the related control problems were significant contributions. In the field of general applications, the subjects of light traction, heavy traction, and the economics of power supply, as well as developments in Diesel electric locomotives have been well covered.

In Table IV, the papers have been classified on the basis of the technical committee structure in the Institute. Papers jointly sponsored have been indicated by half credits respectively. This is only one of several possible bases for the classification of papers. For example, if all of the papers which dealt with electronic applications, such as in the fields of electronic power converters, industrial control, electric heating, communication, and instruments and measurements were classified under electronics, there would be a great many more electronics papers. A number of valuable papers filling a definite need have been brought forth in the fields of electronic instruments, servomechanisms, and the heat pump. There also has been an increase in the number of communication papers presented during the year.

Midwest General Meeting. The meeting held in Chicago, November 3–7, inaugurated the first of the Midwest general meetings designed to fill a need in that section of the

Table III. Number of Papers Presented During the Year Ending April 30, 1948*

Meeting	District	Advance Copy Only	Conference Papers	Transactions	Total	Attendance
Summer, Montreal		7	39	54	119	1,451
Pacific Coast, San Diego			20	16	36	589
Middle Eastern, Dayton	12	7		21	40	502
Midwest, Chicago		1	30	29	60	1,449
Winter, Pittsburgh		12	118	87	217	3,081
Great Lakes, Des Moines	8	3		10	21	354
North Eastern, New Haven	24		7	16	47	669
	44	30	214	233	540	8,095

* Repeated presentations not included.

Table IV. Classification of Papers for Year Ending April 30, 1948

	Summer Montreal	Pacific Coast San Diego	Middle Eastern Dayton	Midwest Chicago	Winter Pittsburgh	Great Lakes Des Moines	North Eastern New Haven	Total	Per Cent
Communication and Science Group									
Basic sciences				3.0	6.0	1.5		10.5	
Communication	8.0	2.0	0.5	3.0	14.0	0.5		28.0	
Instruments and measurements	5.5	3.0	2.0		11.5	1.5	2.0	25.5	
Electronics	1.0		0.5		5.5	1.5	1.0	9.5	
Nucleonics									
Application of electricity to therapeutics	1.0				1.0			2.0	
									28.7
General Applications Group									
Air transportation		4.0	8.0					12.0	
Domestic and commercial application					2.0			2.0	
Land transportation	5.0				11.0		0.5	16.5	
Production and application of light			0.5					0.5	
Marine transportation	1.5							1.5	
									12.4
Industry Group									
Chemical, electrochem, and electrometallurgical				0.5	1.0	0.5		2.0	
Electric heating	3.0				1.0			4.0	
Electric welding									
General industry application	4.0							4.0	
Industrial control	4.0	0.5		1.0	3.5			9.0	
Industrial power systems	1.0			1.0	3.0			5.0	
Mining and metal industry		1.0			2.0			3.0	
									10.3
Power Group									
Carrier current	2.0				0.5			2.5	
Electronic power converter					0.5		0.5	1.0	
Insulated conductor					5.0		1.0	6.0	
Power generation	4.0	1.5		3.0	8.5	1.0		18.0	
Protective devices	1.0			1.0	2.0			4.0	
Relay	1.5				2.0		1.0	4.5	
Rotating machinery	5.0	0.5	16.0	5.0	5.0	2.0	4.5	38.0	
Substation	0.5				1.0			1.5	
Switchgear	5.0	1.0		1.5	5.0	3.0	3.5	19.0	
System engineering	0.5			2.0	0.5	0.5		3.5	
Transformer	2.5			2.0	2.5		1.5	8.5	
Transmission and distribution	5.0	2.5	0.5	7.0	5.0	1.0	0.5	21.5	
									48.6
Totals	61	16	28	30	99	13	16	263	

country and relieve the congested winter general meetings. Sixteen technical sessions and conferences were held, one of which was joint with the National Electronics Conference, and three general sessions. The meeting was very successful with a total registration of 1,449, and for the future indications are that the programs for this meeting will be larger. For the 1948 Midwest general meeting to be held in Milwaukee, 35 technical sessions and conferences already have been scheduled.

Future Meetings. The program for the summer general meeting in Mexico City has been completed, and the programs for the Pacific general meeting and the Midwest general meeting are well under way. Several sessions already are in prospect for the 1949 winter general meeting in New York.

Administration Group Committees

BOARD OF EXAMINERS

Statistics relating to the number of cases handled by the board of examiners during the year 1947–48 are given in Table V. The current total represents a slight increase in the record figures for 1946–47, or about 72 per cent more than the 1945–46 total. These figures are exclusive of those covering "Enrolled Students" which rose from 3,931 to 5,894, or about 50 per cent.

In the past the examiners frequently have emphasized the need for a more careful preparation of all applications, both for admission and transfer. The results of these pleas are evident in a considerable decrease in the number of transfers held up by the need for additional information. The examiners wish therefore to express their appreciation for the excellent work carried on by the Section transfer committees aiding in this connection. With regard to applications for direct admission, the examiners still find it necessary to ask frequently for more detailed statements of record and additional supporting references. A bare statement of titles of positions held with dates is not sufficient to enable the board of examiners to arrive at a decision on eligibility. Likewise, the fact that an applicant has reached the lower age limit specified in the constitution is no proof of eligibility.

Among the hundreds of cases that have been passed upon by the board of examiners, particularly since the end of the war, there have been many from foreign countries. This number seems to be growing at an unusually rapid rate. The examiners therefore have expressed the opinion that this situation should be called to the board of directors' attention. As the dues paid by such members are determined through adjustments based on currency exchange rates, resulting in payments in many cases 40 per cent below the stated dues paid by engineers in the United States, it would seem that in accepting foreign applicants under such conditions we may be aiding in making more acute a recognized existing shortage of funds for fulfilling our obligations to the membership in the United States.

COMMITTEE ON CONSTITUTION AND BYLAWS

Submitted by the committee on October 10, 1947, and adopted by the board of directors on November 5, 1947, were the following recommendations.

1. **Constitution.** In sections 39, 40, 50, 59, changing the word "convention" to "general meeting."

2. **Bylaws.** In sections 6, 7, and 11, changing the words "United States or Canada" to "United States, Canada, or Mexico."

Section 39. For the word "national," substituting the word "international."

Section 65. Adding to the list of general committees the "committee on management."

Section 85. For the word "national," substituting the word "general."

Section 85. Deleting last paragraph to remove repetition.

3. **New Section.** Outlining the membership and the scope of the new committee on management.

Submitted by the committee on January 7, 1948, and adopted by the board of directors on January 29, 1948, were the following recommendations.

1. **Constitution.** In section 10 requiring proposals for transfer to grade of Fellow to originate from "five Fellows," rather than from "five Members or Fellows."
Section 20. Deleting entire section, to do away with "Life Membership."

Section 32. Changing the mailing date of election ballots from "the first week in April" to "April 15."

Section 35. Redefining the membership of the board of directors to read: "The board of directors shall consist of the president, the two surviving past presidents most recently retired, the vice-presidents, the directors, and the treasurer."

Section 44. Changing the requirement that "each standing committee shall include at least one member of the board of directors" to requiring that "each co-ordinating committee shall include at least one member of the board of directors."

Also, transferring this clause to section 65 of the bylaws.

2. **Bylaws.** In sections 6, 7, 22, and 63, deleting the words ("Journal of A.I.E.E.").

Section 21. Deleting the heading "Life Membership" and the table in section 22, headed "Life Membership Rates." Also, rewording section 21 to take care of present "Life Members."

Section 23. Changing the mailing date of election ballots from "the first week in April" to "April 15."

Section 33. Making optional the appointment of a District co-ordinating committee, and specifying that if appointed, such a committee "shall function continuously in an executive capacity for the District executive committee."

Section 35. Providing that a District meeting committee shall be "composed of members within the District, preferably located in the area where the meeting is to be held."

Section 35. Deleting the word "national" before the words "technical program committee."

Section 35. Changing the world "national" to "general."

Section 65. Under the heading "General Committees," adding the committees on education, management, Members-for-Life fund, Institute publicity, and transfers.

Section 65. Under the heading "Technical Committees," adding the new "committee on computing devices," and rearranging all the technical committees under their proper co-ordinating committees.

Table V. Application for Admission and Transfer, 1947–1948

Applications for Admission		
Recommended for grade of Associate	2,160	
Re-elected to the grade of Associate	90	
Not recommended	1	
		2,251
Recommended for grade of Member	297	
Re-elected to the grade of Member	11	
Not recommended	85	
		393
Recommended for grade of Fellow	6	
Not recommended	1	
		7
Applications for Transfer		
Recommended for grade of Member	472	
Not recommended	32	
		504
Recommended for grade of Fellow	86	
Not recommended	1	
		87
Students		
Recommended for enrollment as Students		5,894
Total		9,136

Section 68. Adding to the technical program committee the chairmen of the technical co-ordinating committees, and the chairman of each of the following committees: education and research.

3. **New Section.** Defining the scope of the transfers committee.

Section 70. Adding to the planning and co-ordination committee the chairman of each co-ordinating committee.

Section 97. Clarifying the procedure relative to revisions of technical papers, before publication by the Institute.

The following recommendations of the committee were adopted by the board of directors on April 23.

1. **Bylaws.** Section 22. Defining the "suggestion to be considered by the nominating committee" to be those "from the general membership."

Section 32. Adding to the District executive committee a member of the Sections committee who is resident in the District.

Section 36. Changing the minimum number of members, who may petition for the formation of a Section from 25 to 50.

HEADQUARTERS COMMITTEE

As requested by the board of directors, the committee considered a proposal that the main lobby of the Engineering Societies Building be converted into a common board room, a suggestion which had been under consideration by the other founder societies and the United Engineering Trustees, Inc. The committee recommended that the proposal be not endorsed, as the amount of use of the AIEE board room precludes its discontinuance, the modification of the lobby was considered to be fundamentally undesirable, and the cost would not be justified by the benefits that would be derived.

The committee has kept in mind continuously the need for more office space in the building, and discussed various possibilities.

COMMITTEE ON INSTITUTE PUBLICITY

The committee on Institute publicity had as its primary task the handling of public relations for the winter general meeting held this year in Pittsburgh during the latter part of January. It was decided again to retain the services of a professional public relations counsel. Public Relations Research Service, Inc., of Pittsburgh was authorized to carry on this work, and it is believed that the assignment was completed in an effective manner.

Publicity for the summer general meeting in Mexico City is being handled by the local organization with assistance and suggestions from the general committee. Material on the over-all objectives and activities of the Institute has been sent to Mexico City, and the committee will continue to provide any other assistance that is required.

At the request of President Hull, the committee has formulated and submitted to the board of directors a draft of a statement of Institute publicity policy. The committee's suggestions recommend consideration of publicity as a continuing and integrated activity rather than a series of special efforts centered about a few important meetings.

At the same time, the committee submitted a tentative definition of its scope for inclusion in the bylaws.

COMMITTEE ON TRANSFERS

Continuing the work started last year by the committee on transfers, the effort again this year has been directed toward encouraging the Sections to maintain active transfers committees and toward providing all Sections with information on methods of operation which have been used with success as reported by individual Sections. To arrive at a best procedure to meet the needs of the greatest number of Sections has been the aim of the committee on transfers.

At the start of this fiscal year, the Institute made the committee on transfers a standing committee. This action aided materially in encouraging the Sections to establish their own transfers committees also as standing committees. Practically all Sections now actively and continuously are urging their qualified members to apply for high grades of membership. The necessary qualifications for each grade are more uniformly and generally understood.

The committee on transfers reported during the Sections committee meeting in Pittsburgh in January as part of the presentation, "The Model Section." That report said, in part:

> The activities of committees on transfers should not be of a campaign nature, in contrast with the work of membership committees. The work of transfers, consistently and continuously, year in and year out, should be to present the opportunity to qualified members to advance in grade of membership. . . . For the good of the individual and the welfare of the Institute it takes a group in each Section—"The Model Section"—to analyze its members and to encourage its qualified members to become what they should be in grade of membership. Our job is not to make members of higher grade but to present the benefits of the higher grades of membership to the extent that personal inertia is overcome. It is an honor to be an Associate. It is a higher honor to be a Member. It is the highest honor to be a Fellow of the AIEE.

On March 22, the committee on transfers and the Sections committee jointly sent a questionnaire to all Sections requesting pertinent information on their activities and experiences in transfers work. Reports on their most successful techniques also have been requested. Replies are coming in and will be correlated in a final report to be turned over to the succeeding committee on transfers of the Institute. If this report results in a generally acceptable and enduring plan of action for continuing grade transfers with minimum effort in the Sections, the primary aim of this committee will have been accomplished.

MEMBERSHIP COMMITTEE

In evidence of the active work carried on by Section membership committees during the past year, the total membership of the Institute increased to 28,400 on April 30, 1948—1,922 more members than enrolled for the same time last year. Table VI of membership statistics shows the nature of the changes in membership during the year. Mention should be made that the losses include 200 cases of nonresident members for whom inactive status had been maintained throughout the war period, who have not found it possible to become reinstated.

Applications for admission to membership received during the year totaled 3,753, a record figure for the Institute. Many of the applications still are pending, and all indications point to a steady growth in the membership total.

At the end of April 1947, 1,090 members were in arrears for dues, whereas this year the number had increased to 1,288. However, the increase amounts to less than one-half of one per cent of the membership total, and therefore is not significant.

The phenomenal growth in Student membership is shown in Table VIII, 13,917 persons being so enrolled with the Institute on April 30, 1948. From this source there should be a substantial increase in the membership of the Institute during the next few years.

The membership committee continued to encourage decentralization of its operations and increased activity on the part of the District vice-chairmen. At the beginning of the fiscal year, a recommended procedure of operation was sent out to all the District vice-chairmen for their guidance in handling membership activities in their Districts.

A small executive subcommittee of the membership committee was established. This subcommittee met at intervals of two months during the year and handled the general operational problems of the membership committee.

A membership committee meeting was held in Pittsburgh at the winter general meeting. At this committee meeting, presentations were made on the various problems connected with stimulating membership. This committee meeting was attended by a number of members of the membership committee and executives of the AIEE. Copies of the presentations were sent to all members of the membership committee so as to disseminate the new ideas which were presented.

A very active program was followed with all of the Sections to promote the advancement from Student to Associate grade. This program was very successful and the number of applications from Students this year exceeded all previous records. The membership committee continued its program of co-operation with Student Branches, and members of the committee presented talks on the benefit of AIEE membership before many of the Student Branches.

A subcommittee studying an alternative method of advancing Students to Associate membership continued to work with the committee on Student Branches in an effort to work out an improved method. It is planned to attach an application for the grade of Associate to the bill for Student dues which is sent to graduating seniors. In the letter transmitting this bill, the

Table VI. Membership Statistics for Fiscal Year Ending April 30, 1948

	Honorary Members	Fellows	Members	6-Year Associate	Associate	Subtotals	Totals
Membership April 30, 1947	9	1,039	7,500	7,652	10,278		26,478
Additions							
New members qualified		3	281		2,478	2,762	
Former members reinstated or re-elected		7	110	76	120	313	
Subtotals		10	391	76	2,598	3,075	
Transfers		80	511	1,206		1,797	
Totals		90	902	1,282	2,598	4,872	
Deductions							
Died	1	34	75	59	25	194	
Resigned		2	45	101	118	266	
Dropped		5	86	251	351	693	
Subtotals	1	41	206	411	494	1,153	
Transfers			79	417	1,301	1,797	
Totals	1	41	285	828	1,795	2,950	
Net Changes	−1	49	617	454	803	1,922	
Membership April 30, 1948	8	1,088	8,117	8,106	11,081		28,400

Table VII. Number of Applications Received From Student Members and From All Others

Year Ending April 30	Students	All Others	Total
1948	1,481	2,272	3,753
1947	938	2,331	3,269
1946	308	2,453	2,761
1945	249	2,179	2,428
1944	466	1,908	2,374
1943	783	1,431	2,214

Table VIII. Number of Student Members as of April 30

Year	New Applications	Renewals	Total
1948	7,876	6,041	13,917
1947	5,092	3,929	9,021
1946	2,574	2,513	5,087
1945	2,326	2,287	4,613
1944	2,242	2,656	4,898
1943	2,512	3,200	5,712

Table IX. Record of AIEE Membership

Year	Total May 1	Year	Total May 1	Year	Total May 1
1884	71	1906	3,870	1927	18,344
1885	209	1907	4,521	1928	18,265
1886	250	1908	5,674	1929	18,133
1887	314	1909	6,400	1930	18,003
1889	333	1910	6,681	1931	18,334
1890	427	1911	7,117	1932	17,550
1891	541	1912	7,459	1933	17,019
1892	615	1913	7,654	1934	15,230
1893	673	1914	7,876	1935	14,269
1894	800	1915	8,054	1936	14,600
1895	944	1916	8,202	1937	15,308
1896	1,035	1917	8,710	1938	16,078
1897	1,073	1918	9,282	1939	16,605
1898	1,098	1919	10,352	1940	17,213
1899	1,133	1920	11,345	1941	17,886
1900	1,183	1921	13,215	1942	18,944
1901	1,260	1922	14,263	1943	20,161
1902	1,549	1923	15,298	1944	21,407
1903	2,229	1924	16,455	1945	23,072
1904	3,027	1925	17,319	1946	25,090
1905	3,460	1926	18,158	1947	26,478
				1948	28,400

seniors will be invited to apply for Associate membership immediately, and the processing of such applications will be delayed so that final action is taken at the time Student membership is about to expire.

A revised edition of a "Section Membership Committee Manual," was completed and sent out to all the Sections at the beginning of the fiscal year.

It is recommended that the membership committee in the future be made up of a chairman, vice-chairman, ten District vice-chairmen, and 13 members-at-large. The District vice-chairmen should serve a period of two years, with half of the group changing each year. Ten of the members-at-large should be former District vice-chairmen, and half of this group changed each year. The other three members-at-large should be liaison members from the board of directors, the committee on Student Branches, and the Sections committee. If this plan is followed in appointing the membership committee each year, the Institute will have the benefit of a maximum amount of experience on the committee, and be assured of a continuity of carrying out membership committee policy.

It also is recommended that appointees to the office of District vice-chairman have Section membership background.

Professional Group Committees

PROFESSIONAL GROUP CO-ORDINATING COMMITTEE

The committee co-operated with President Hull in selecting members for the several committees in the professional group.

A start was made toward closer co-ordination of the work of the committee on Student Branches and the committee on education. The problem of consolidation or closer co-ordination still is being studied and several joint activities are being considered.

Considerable correspondence was carried on between chairmen of the committees within the professional group regarding the proposal that the Institute join the co-operating organizations of the National Security Committee. A recommendation was agreed upon and submitted to the board of directors. This recommendation, which was adopted by the directors, was to the effect that, first, the Institute cannot take a stand on the subject of universal military training and, therefore, postpones the appointment of a representative to the National Security Committee, and, second, that the Institute is willing to work with any organization in the preparation of a training program to the end that the most effective use of technically-trained personnel is made.

COMMITTEE ON EDUCATION

A session was sponsored at the summer general meeting, with four educational papers. The committee will present a session at the 1948 summer general meeting featuring three papers, and, in co-operation with the committee on Student Branches, plans a joint session at the Midwest general meeting on the general theme of the electrical engineering profession. The intent of this meeting is to present sound information to the student membership concerning the profession.

Through the efforts of this committee, a plan for the publication of a "Bibliography of the History of Electrical Engineering," has been evolved. This material has been gathered by Professor T. J. Higgins over a period of many years, and represents a worthy addition to the history of electrical engineering.

Two members of the committee have been appointed to co-operate with the committee on Student Branches in drafting a program of common interest. This subcommittee is urged to study such topics as licensing of engineers, greater co-ordination between the various branches of engineering and professional aspects of engineering as a career, and any other such topics particularly applicable to the student engineer.

COMMITTEE ON STUDENT BRANCHES

A considerable number of inquiries have been processed concerning the operation of joint Student Branches, and requests were received for the establishment of new AIEE Student Branches. A new branch was established at Wayne University in Detroit during the past year, and a recommendation has been made to the board of directors for the establishment of one additional Branch outside of the continental limits of the United States.

At the meeting in Montreal, in June 1947, there was an extensive discussion of the criteria for the establishment of new Student Branches. The discussion centered primarily around the interpretation of the phrase, in section 64 in the bylaws, which reads "an established engineering society in a college or technical school of recognized standing may, upon application of its officers and a member of the Institute...... become associated with the Institute." It was the consensus of opinion of those at this meeting that the term "recognized standing" should be defined as Engineering Council for Professional Development accrediting in so far as the establishment of new Student Branches was concerned, because the activities of ECPD are supported by the AIEE, and there seemed to be no other clear-cut criteria on which recommendations could be based. It was decided that ECPD accrediting should apply in the United States, and that outside, where ECPD accrediting is not in effect, an approximately equivalent standard would be required.

Work was carried on by a joint subcommittee between the membership committee

Table X. Deaths of AIEE Members Reported in *ELECTRICAL ENGINEERING*

Name	Date of Election	Date of Death	Grade at Death	Obituary Notice in *ELECTRICAL ENGINEERING*
Allcock, Harold J.	M '13		M.	Jan. '48, p. 103
Andrus, Lucius A.	A '03		F.	Mar. '48, p. 301
Atkinson, Albert A.	A '07	Jan. 20, '47	M.	May '47, p. 507
Baldwin, Edward A.	A '07	Sept. 27, '47	A.	Dec. '47, p. 1256
Barrett, William R.	A '22	Sept. 22, '47	A.	Dec. '47, p. 1256
Benjamin, George R.	A '07	April 28, '47	A.	June '47, p. 617
Berger, David	A '28		M.	Feb. '48, p. 200
Berry, Henry P.	A '26	April 22, '47	M.	Nov. '47, p. 1151
Biddle, James G.	A '96		A.	Mar. '48, p. 301
Biegler, Philip S.	A '07		F.	Mar. '48, p. 301
Bostwick, Thomas J.	A '18	May 8, '47	M.	July '47, p. 711
Brooks, Morgan	A '90	April 23, '47	F.	July '47, p. 711
Brown, Charles C.	A '22	May 18, '47	F.	July '47, p. 712
Buchman, Richard P.	A '38	Mar. 24, '47	A.	June '47, p. 618
Buckhold, John F.	A '46	Jan. 3, '48	A.	April '48, p. 408
Bulloch, George E.	M '41		M.	Mar. '48, p. 301
Chadwick, George A.	M '46	Oct. 1, '47	M.	Dec. '47, p. 1257
Chesney, Cummings C.	A '94	Nov. 27, '47	F.	Jan. '48, p. 102
Colby, Safford K.	A '03	Aug. 4, '47	A.	Oct. '47, p. 1029
Coit, Norman H.	A '19	Sept. 3, '47	F.	Nov. '47, p. 1152
Collins, William H.	M '46	June 3, '47	M.	Nov. '47, p. 1151
Cowles, Joseph W.	A '02		M.	Nov. '47, p. 1151
Crocker, Theodore D.	M '44	June 29, '47	M.	Sept. '47, p. 934
Cummins, Alden C.	A '11	July 10, '47	A.	Sept. '47, p. 934
Deininger, Harry W.	A '12	April 18, '47	M.	June '47, p. 617
Dennison, Boyd C.	A '06	Aug. 19, '47	M.	Oct. '47, p. 1029
Dexter, Jr., Howard W.	A '26		M.	Mar. '48, p. 302
Diemer-Hansen, Jens L.	A '07	April 24, '47	M.	Aug. '47, p. 847
Doyle, Harold K.	M '38	Sept. 27, '47	F.	Dec. '47, p. 1255
Elmer, William	A '90	May 6, '47	F.	July '47, p. 712
Entz, Justus B.	A '90	June 8, '47	A.	Aug. '47, p. 847
Evans, Robert D.	A '21	May 8, '47	F.	July '47, p. 711
Faile, Edward H.	M '31	Feb. 21, '47	M.	Dec. '47, p. 1256
Foley, Hiram S.	A '07		M.	Feb. '48, p. 200
Foote, Benjamin R.	A '19		M.	Nov. '47, p. 1152
Forster, Frank T.	A '16	May 11, '47	A.	Oct. '47, p. 1030
Germain, Henry A.	A '25		A.	Nov. '47, p. 1151
Goodale, Edgar C.	A '27	April 28, '47	M.	July '47, p. 711
Graner, Ladislas P.	A '23	Sept. 24, '47	M.	Nov. '47, p. 1152
Greves, George L.	A '15	Sept. 6, '47	M.	Nov. '47, p. 1152
Harden, William H.	A '15		M.	Feb. '48, p. 200
Havill, Owen A.	A '11		F.	Feb. '48, p. 200
Hayes, Hammond V.	A '89	Mar. 22, '47	F.	June '47, p. 617
Heath, James G.	A '37	April 6, '47	A.	Nov. '47, p. 1151
Hewlett, Ernest F. J. H.	A '99	Jan. 22, '47	M.	July '47, p. 711
Higbie, Henry H.	A '08	Aug. 3, '47	F.	Nov. '47, p. 1151
Hirsch, John G.	M '23		M.	Jan. '48, p. 104
Hobble, Arthur C.	A '03	Mar. 25, '47	M.	June '47, p. 617
Hollister, Francis H.	A '08	Sept. 20, '47	F.	Dec. '47, p. 1255
Huang, Theodore S.	M '37		M.	Sept. '47, p. 934
Hull, Paul B.	A '39	Jan. 5, '47	A.	May '47, p. 507
Jones, Thomas D.	A '31	May 24, '47	A.	Aug. '47, p. 847
Karapetoff, Vladimir N.	A '03	Jan. 11, '48	F.	Feb. '48, p. 199
Koiner, Cyrus W.	A '04	Sept. 29, '47	F.	Dec. '47, p. 1256
Lowe, Robert E.	A '34	Dec. 15, '46	M.	June '47, p. 617
Ludwick, William L.	A '42		M.	Feb. '48, p. 199
MacMillan, Campbell	A '08	Jan. 24, '48	M.	April '48, p. 408
Mason, Karl C.	A '19	Mar. 16, '47	A.	June '47, p. 618
Maxwell, Alexander	F '37	Feb. 10, '48	F.	April '48, p. 407
Meyerherm, Charles F.	A '14	July 27, '47	M.	Sept. '47, p. 934
Mixer, Charles A.	A '03	Oct. 24, '47	A.	Dec. '47, p. 1257
Morehouse, Lyman F.	M '16	May 1, '47	F.	July '47, p. 711
Morice, John H.	A '12	Feb. 17, '47	A.	Aug. '47, p. 847
Mullen, James J.	A '12	June 23, '47	F.	Oct. '47, p. 1029
Munro, James C.	M '45		M.	Nov. '47, p. 1152
Murmann, Frederick J.	A '07		M.	Nov. '47, p. 1152
McCammon, Floyd F.	A '28	Sept. 20, '47	M.	Dec. '47, p. 1256
McCurdy, Ralph G.	A '16		F.	Mar. '48, p. 300
McGraw, James H.	A '01	Feb. 21, '48	A.	April '48, p. 407
McHugh, Henry R.	A '45	April 19, '47	A.	July '47, p. 712
Nash, Luther R.	A '03	Aug. 10, '47	M.	Oct. '47, p. 1029
Neall, Newitt Jr.	A '03		F.	Mar. '48, p. 301
Oesterreicher, Sandor I.	A '07	Oct. 31, '47	M.	Jan. '48, p. 104
O'Sullivan, Frederick A.	A '19	May 18, '47	A.	Aug. '47, p. 847
Page, Wilson K.	A '10	Aug. 6, '47	A.	Jan. '48, p. 104
Palmer, Granville E.	F '36		F.	Mar. '48, p. 301
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Persio, Louis N.	A '34	Aug. 6, '47	A.	Nov. '47, p. 1151
Pilkington, John H.	A '26	Nov. 10, '47	M.	Jan. '48, p. 103
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Rau, Otto M.	A '03	April 3, '47	M.	June '47, p. 618
Ready, Lester S.	A '15	April 9, '47	F.	July '47, p. 711
Reid, William M.	A '20		A.	July '47, p. 712
Rice, Edward Y.	A '13	Sept. 29, '47	A.	Dec. '47, p. 1256
Richards, Samuel H.	M '39	Jan. 9, '47	M.	May '47, p. 507
Richey, Robert R.	A '43	Mar. 31, '47	A.	June '47, p. 617
Rubel, Walter G.	A '18	July 24, '47	M.	Nov. '47, p. 1151
Sappington, Richard D.	A '19		A.	Nov. '47, p. 1152
Scattergood, Ezra F.	A '08	Nov. 15, '47	F.	Jan. '48, p. 103
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Sirrine, Joseph E.	A '05	Aug. 7, '47	M.	Oct. '47, p. 1030
Slack, Roy C.	M '46		M.	Jan. '48, p. 104
Smith, Joseph B.	A '94		A.	Sept. '47, p. 934
Smith, Walter L.	A '23	June 28, '47	A.	Sept. '47, p. 934
Soares, John S.	A '09		A.	Feb. '48, p. 199
Stoller, Hugh M.	M '19	Nov. 17, '47	M.	Jan. '48, p. 103
Storer, Norman W.	A '95	June 5, '47	F.	Sept. '47, p. 934
Thomas, Raymond S.	A '17	April 18, '47	A.	July '47, p. 712
Torrey, Carleton E.	A '05	Aug. 15, '47	A.	Nov. '47, p. 1151
Truran, Walter W.	A '23	Mar. 7, '47	M.	May '47, p. 507
Turzegano, Jr., Paul J.	A '45	Sept. 29, '47	A.	Dec. '47, p. 1257
Van Sanford, Russell	M '31	Feb. 14, '47	M.	June '47, p. 618
Van Veen, John	A '20	June 9, '47	M.	Aug. '47, p. 847
Wagner, Herbert A.	A '98	Dec. 5, '47	M.	Feb. '48, p. 199
Waring, Tracey D.	A '06	April 27, '47	M.	June '47, p. 617
Waterman, Frank N.	A '93		F.	Mar. '48, p. 301
Weber, Fred D.	A '09	April 5, '47	M.	July '47, p. 712
Wellwood, Arthur R.	M '22	Mar. 5, '47	F.	July '47, p. 710
Wheadon, Frederick W. H.	A '17		A.	July '47, p. 712
White, Francis J.	A '02	Oct. 4, '47	M.	Dec. '47, p. 1255
Wickenden, William E.	A '07	Sept. 1, '47	F.	Oct. '47, p. 1029
Willson, Frank G.	A '05	July 29, '47	M.	Oct. '47, p. 1029
Woodward, Mark R.	A '11		M.	Nov. '47, p. 1151

and the committee on Student Branches, to determine what could be done to encourage more Student members to become Associates upon graduation. A suggested procedure was presented at the winter general meeting by those members of this subcommittee who represented the committee on Student Branches. This suggested procedure has been submitted to all Student Branch counselors for a vote of approval or disapproval. The vote on this shows approximately ten to one for approval. The suggested procedure put up for vote read as follows:

> A student may apply for Associate membership shortly before graduation. This may be done through an application form given by the faculty counselor or by the faculty counselor and a member of the membership committee from the local Section. The usual three references are required. This application will be transmitted to headquarters by the counselor upon graduation of the student and will be processed in the usual manner. The dues will continue at the Student rate until the expiration of the time limit for Student membership even though the member is now of the Associate grade. This would require revision of article IV, section 19 of the constitution
>
> In the event of arrears, that is, the member does not pay his Associate dues at the expiration of the time limit for Student membership rate or within three months thereafter, he will be placed on the suspended list and receive no further publications. This would require revision of section 18 of bylaws.
>
> The present procedure also will remain in force as an alternate method of transfer from Student status to Associate grade. (Note this procedure at this time is only a proposal from the committee on Student Branches which at a later date may be forwarded to the board of directors. It is not now effective.)

The committee on Student Branches is assisting in re-editing the booklet "The Electrical Engineer" which is intended to orient and to guide high school students who are contemplating a career in electrical engineering.

The committee on Student Branches expects to enter into a co-operative arrangement with the committee on education, to sponsor a session at the Midwest general meeting in Milwaukee in October.

SPECIAL COMMITTEE TO REVIEW PRACTICES OF INSTITUTE PRIZE AWARDS

The draft of the proposed revised practice covering award of Institute prizes was reviewed with the board of directors and at the conference of vice-presidents and District secretaries in Montreal, in June 1947. After further revisions, the proposal was submitted to the board of directors and approved at the August 1947 meeting, at which time the special committee was discharged. The revised practices appeared in the December 1947, issue of *ELECTRICAL ENGINEERING*, and became effective January 1, 1948.

UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

A considerable amount of technical work has been resumed actively during the year by the advisory committees of the International Electrotechnical Commission. The following meetings were held:

Group of experts on lamps, caps, and holders of advisory committee 6, London, May 1947

Advisory committee 30—extra-high voltages, Lucerne, October 1947

Advisory committee 12—radio communication, Lucerne, October 1947

Advisory committee 23—electric accessories, Lucerne, October 1947

International special committee on radio interference, Lucerne, October 1947

In addition, a meeting of the council was held in Zurich in June 1947, and of the committee of action in Brussels in October 1947.

The USNC was represented at all of the meetings. At the group of technical meetings held in Lucerne, it was represented by a strong delegation. At these meetings, all of which were the first technical ones since the war, substantial progress was made in getting under way the work of the advisory committees concerned. The European representatives are extremely anxious to meet with their colleagues from the rest of the world because during the war they had no opportunity to exchange information of a technical nature. They are anxious to press the work of the commission as much as possible, as they believe that this work will assist them in the many reconstruction and rehabilitation projects with which they are faced through war damage in their countries and through the demands of construction delayed during the war years.

The meetings of the council and the committee of action were concerned primarily with expediting resumption of technical work and with consummating the affiliation of the International Electrotechnical Commission with the International Organization for Standardization, as its electrical division. This affiliation now has been completed by its approval by the national committees. The central office of the IEC has been moved from London to Geneva where it occupies a building jointly with the ISO. It should be pointed out that the IEC retains its name, procedure, and freedom of action. It confidently is expected that this affiliation will give impetus and strength to the international standardization movement and that there will be important economies as well.

Meetings of the following advisory committees will be held in London and Paris in July, 1948

Advisory committee 30—Extra-high voltages
Advisory committee 31—Flameproof enclosures
Advisory committee 32—Fuses
Advisory committee 28—Co-ordination of insulation

The Swedish national committee has invited additional advisory committees to meet in Stockholm in October 1948. The committees which are to meet have not been definitely agreed upon.

During the year a reorganization of the electrical standards committee has been under way and has resulted in the addition of a number of new organizations in the field of electronics and communications. The membership of the ESC forms the nucleus of the USNC. While this matter was pending, no meeting of the USNC was held. Now that the membership has been completed, a meeting soon will be held. The work of the USNC has been carried out during the year by correspondence and through meetings of various technical advisory groups.

Technical Committees

Power Group

COMMITTEE ON ELECTRONIC POWER CONVERTERS

The status of this committee was changed, at the beginning of the 1947–48 administrative year, from a subcommittee of the electronics committee to a full committee in the power group. The membership was enlarged, and several liaison members from other committees were added.

Six subcommittees were established, as listed in the January 1948 issue of *ELECTRICAL ENGINEERING.* The organization of a West Coast subcommittee was initiated, and a chairman was appointed.

At the first meeting of the committee held in Pittsburgh on October 6, 1947, the subcommittees were organized, and the activities for the year were planned. A second meeting was held in Syracuse, N. Y., on May 17. Most of the subcommittees held meetings during the year.

A conference on the operation of mercury-arc rectifiers was held in Montreal on June 13, 1947, during the AIEE summer general meeting, under the sponsorship of the committee. Digests of the papers were published in the October 1947 issue of *ELECTRICAL ENGINEERING.*

A conference on mechanical rectifiers was held in Pittsburgh on January 29, 1948, during the AIEE winter general meeting, under the joint sponsorship of this committee and the electronics committee.

A working group of the committee has prepared a paper "Mercury-Arc Power Converters in North America," for presentation at the AIEE summer general meeting in Mexico City. The paper is a comprehensive report on the design and application of mercury-arc power converters.

The committee is planning to sponsor a conference on education in power electronics, in co-operation with other AIEE committees, to be held during the 1949 winter general meeting.

In addition to the committee activities outlined, several of the subcommittees carried on activities within their scopes.

Electronic Converter Application Subcommittee. This subcommittee is preparing questionnaire forms for collecting data on the operation and maintenance of mercury-arc rectifiers and on the characteristics of the a-c and d-c power circuits in rectifier installations. A working group was organized and started the preparation of a report on inductive co-ordination relating to the d-c circuits of rectifier installations. This report will be similar to the committee report "Inductive Co-ordination Aspects of Rectifier Installations," published in 1946, which dealt with the a-c systems of rectifier installations.

Electronic Converter Circuits Subcommittee. This subcommittee is preparing a report on portection of electronic power converters. The report is nearing completion, and it is planned to present it at the next Midwest general meeting of the AIEE.

Papers and Speakers Subcommittee. This subcommittee is preparing a bibliography on electronic power converters. The English-language section of the bibliography will be ready for publication this year.

Rectifying Devices Subcommittee. The chairman of this subcommittee is participating in the preparation of standards for mercury-arc pool-cathode tubes, which has been started under the sponsorship of the electron tubes subcommittee of the electronics committee. The subcommittee has not undertaken any independent activity.

Rectifier Transformers Subcommittee. This subcommittee is planning a comprehensive paper on the design and characteristics of rectifier transformers.

A proposal has been submitted by the chairman of the electronic power converter committee for enlarging the scope of the committee to include hot-cathode electronic converters, metallic rectifiers, and mechanical rectifiers, in addition to mercury-arc power converters. If this proposal is approved, the hot-cathode electronic converters subcommittee of the electronics committee and the metallic rectifiers subcommittee of the chemical, electrochemical, and electrothermal committee will be combined with the electronic power converter committee. It has been proposed also to change the name of the combined committee to "rectifier committee."

COMMITTEE ON CARRIER CURRENT

In this first year of operation, three full committee meetings have been held and in addition one meeting of subcommittee chairmen. Considerable time has been spent reviewing the activity of the previous joint subcommittee. It was decided to set up project subcommittees for the most important needs only and to retain other activities on file until additional personnel became available. Project subcommittees and status of work are as outlined in the following:

Preparation of an application guide. Work in progress.

Establish methods of measurements at carrier frequencies. Preliminary report circulated for comments. Expected to be ready for presentation as a technical paper in fall of 1948.

Obtain data on power system characteristics at carrier frequencies. Questionnaire sent out to obtain available test data.

Power equipment characteristics at carrier frequencies. Plans made for laboratory tests.

Report on features of traps and coupling capacitors for rural line carrier. Draft of report circulated for approval.

Report on microwave applications. Draft of report circulated for comments. Investigation of reliability of carrier relay channels questionnaire being prepared.

The committee did not sponsor any papers during the year. Plans are being developed for future technical papers and reports.

COMMITTEE ON POWER GENERATION

Concrete evidence of the committee's activities lies in the 13 papers presented at two meetings during the year. Practicality of the programs was attested by the large attendance that they attracted, and the extensive discussions that developed. The session sponsored by the committee at the Midwest general meeting in Chicago was devoted primarily to four papers on the determination of system generating capacity using the probability theory as a basis. The committee report on "Progress in Power Generation, 1940–46," also was presented at this time.

At the winter general meeting in Pittsburgh the power generation session was devoted to four papers on generator excitation systems and to four papers on hydraulic-turbine governor specifications.

The committee held meetings in conjunction with these two general meetings at which it organized its work for future technical sessions. Subcommittee activities reported at these meetings are briefed in the following:

Prime Movers. A symposium on gas turbines is in the process of organization planned for presentation at the next winter general meeting. Steps are being taken to co-ordinate work on a program for promulgating recommended standardization of industrial steam turbines.

Speed Governing. This subcommittee working jointly with the American Society of Mechanical Engineers has issued two specifications to be used on a one year trial basis for steam turbines driving electric generators from 500- to 7,500-kw capacity, and for hydraulic turbines driving electric generators. Continuing efforts are being made in the solicitation of papers on prime-mover speed governing for general educational needs.

Excitation Systems. Papers are in preparation on excitation systems for presentation at coming meetings. The subcommittee now is working on an outline for "Definitions and Terminology on Excitation Systems for Synchronous Machines."

Station Design. Work is under way in organizing sessions on station descriptions and on automatic and supervisory control systems for central stations.

Hydroelectric Systems. Four papers have been arranged for presentation at the Pacific general meeting on the subjects of station bus arrangements, transmission line and switchgear connections, and pumping at various plants.

Other papers are in preparation for future meetings on the subjects of Grand Coulee and adaptation of generators to synchronous condenser service.

Pacific Coast. This subcommittee was organized to give a broader opportunity for members on the West Coast to participate directly in the organization of committee technical sessions. From several meetings of these members an extensive list of proposed subjects for future meetings was developed.

COMMITTEE ON RELAYS

In its first year of full committee status, the AIEE relay committee sponsored six formal papers, eight conference papers, and three conference sessions. The committee has contributed suggestions to assist with the expanded number and scope of technical committees and has engaged in joint projects with other committees. The principal technical activities were carried on through project committees, which are appointed to fulfill a specific assignment and discharged when the project is finished. In addition to three meetings of the full committee, practically all of the project committees have held one or more group meetings.

Generator Protection. To supplement previous information developed on the relay protection of generators, the project committee is making specific investigations of field protection, ground protection with high impedance neutral grounding, protection against motoring, tripping schemes for differential relays, and back-up protection. When these investigations are completed, the project committee findings will be summarized in a committee report.

Bibliography of Relay Literature. A formal paper, "Bibliography of Relay Literature—1944–1946," was presented (by title) at the January 1948 winter general meeting, and is being published in the *PROCEEDINGS.* This bibliography contains a list intended to include all technical articles published in the American and foreign press dealing with protective relaying. Collection of information is continuing so that another publication will be available, probably in 1950.

Co-ordination of Construction and Protection of Distribution Circuits (Joint Group). A study of the correlation of distribution circuit protection practices and construction methods, and the influence of these on the reduction of sustained faults, first was undertaken as a joint project of the (former) AIEE relay subcommittee and distribution subcommittee. The need for developing adequate performance records led to the expansion of the working group into one sponsored jointly by the relay committee and the distribution subcommittee of the AIEE, and the transmission and distribution committee of the Edison Electric Institute.

At a conference session held on January 27, 1948, in Pittsburgh during the winter general meeting, the performance of several distribution systems was summarized, with emphasis on schemes for instantaneous initial circuit breaker opening to protect sectionalizing fuses for transient faults, with subsequent time delay tripping to blow the fuses for sustained faults. Load inrush problems and ground relay protection also were discussed.

A survey is being prepared to obtain data on the relative operating characteristics and resulting degree of service continuity obtainable with various protection methods and construction practices; also, the presentation of formal papers is being encouraged.

Standards for Power Relays. The project committee on Standards for power relays has reviewed the comments and suggestions received following the circulation of a preliminary draft of a proposed revision of ASA Standard 6-37.1. A second draft of the proposed revision is nearly completed and will be circulated to the committee membership soon.

Insulation Levels for Relays and Control Circuits. The results of a survey conducted by the project committee appointed to study desirable insulation levels for relays and control circuits have shown that a test voltage of 1,500 volts alternating current should be adequate for the current, potential, d-c control, and tripping circuits of protective relays. Also, the need has been emphasized for close attention to the overvoltages introduced into control circuits by inductive "kicks" of closing solenoids.

The influence of relay contact spacing on breakdown voltage and on relay operating speeds is being investigated. A formal paper is being prepared outlining the basic factors of this problem and describing methods for suppressing transient overvoltages in relay and control circuits.

Sensitive Ground Protection. The project committee has collected information on available methods for sensitive ground relay protection of transmission and distribution circuits. Several methods used for transmission circuits and unigrounded distribution systems have been reviewed and the investigation of possible methods for improved sensitivity with 3-phase 4-wire common neutral circuits is being continued. A committee report should be available during the next administrative year, summarizing successful methods of sensitive ground protection of three wire systems and outlining the difficulties and limitations of schemes for four wire multigrounded neutral systems.

Transmission Line Protection. Analyses of a hypothetical, heavily loaded transmission system composed of short, medium length, and relatively long transmission lines have been made to crystallize the basic requirements of relay protective schemes and limitations of available methods.

In view of the increasing awareness of the need for improved transmission line performance required by the trend toward higher economic loading of lines, a conference session was held at the January 1948 winter general meeting. Three conference papers were presented at this meeting dealing with the relay protection of short, medium, and long transmission lines. This investigation is being continued along with the encouragement of formal papers.

Electronic Relay Applications. A survey of current practices has been made to determine the existing applications of electronic devices to protective relaying systems. The proper place of electronic devices in the protective relay field has been the subject of widely divergent views, some holding that they should be used whenever possible and others maintaining that applications should be limited to those functions which cannot be performed adequately by electromechanical elements.

To develop reasons for these divergent opinions a conference session was sponsored at the Chicago meeting of November 1947 with one introductory paper presenting the more favorable aspects of electronic relay applications and another covering general considerations including the limitations of such elements. It is believed that this subject warrants the presentation of formal papers and these are being encouraged.

Relay Performance of Current Transformers (Instrument Transformer Subcommittee). A new project committee was organized in September of 1947 to study the relaying performance of current transformers, with emphasis on the extension of methods for calculating the performance of those having high impedance secondaries. Attention also was directed to the wide variations in characteristics of auxiliary current transformers and certain main current transformers designed for mounting in the small space of metalclad switchgear.

As a result of a decision by the power coordinating committee, instrument transformers were placed under the scope of the transformer committee, and that committee organized an instrument transformer subcommittee with representation from the relay and other committees. Since December 1947, this project is being continued under the instrument transformer subcommittee.

Grounding of Instrument Transformer Secondary Circuits. Following the publication of a committee report on "Grounding of Instrument Transformer Secondary Circuits," in the April 1947 *ELECTRICAL ENGINEERING*, it has been agreed that the material should be converted into a form suitable for an operating guide and incorporated in the AIEE Standards. Since such a guide would be included most logically in the Standards on instrument transformers, the material and subsequent comments have been turned over to the instrument transformer subcommittee (of the transformer committee) for inclusion in the next revision of these Standards.

Relaying of Interconnections Between Industrial and Utility Generating Systems. A new project committee was organized in September of 1947 to investigate the special relaying problems encountered in the parallel operation of industrial generating systems with those of utility generating and transmission systems. The work is beginning with a survey of current practices.

Protection of Stations Without High-Voltage Switching. In September of 1947 a new project committee was organized to study various methods which might be used for the relay protection of stations and equipment which are not provided with high-voltage circuit breakers. The improved reliability of power transformers has led to the increasing use of such schemes, and a survey to determine present practices is being undertaken.

COMMITTEE ON ROTATING MACHINERY

At the beginning of the 1947–48 Institute year the former committee on electric machinery was, under the new co-ordinating group organization, divided into several committees, one of which is the committee on rotating machinery. The first problem facing this newly designated committee was to organize so as properly to assume its assigned responsibilities. These included the previous functions of the electric machinery committee as related to rotating machines plus an expanded program to include classes of such machinery which it was felt previously had not been covered adequately. This organization took the form of a main committee with seven subcommittees—administrative, synchronous machinery, induction machinery, d-c machinery, single-phase and fractional-horsepower machinery, insulation, and test code.

The first meeting of the reorganized committee was held in Pittsburgh during the winter general meeting, January 1948. At that meeting, Mr. Steinberg, chairman of the power co-ordinating committee, gave a brief history of the new co-ordinating group activities and stated that after six months of operation, the organization is working well. He then asked for comments from the members of the rotating machinery committee as to their opinions both on the power group functioning and on their own committee activities. The general concensus of opinion indicated a very favorable acceptance of the entire new organization.

The machinery subcommittees then submitted reports on their activities:

Synchronous Machinery. A meeting was held at the winter general meeting at which recommendations were submitted for revisions of test code number 503, and suggestions made for better co-ordination among other codes and standards.

Induction Machinery. Similar actions with respect to codes and recommendations as for synchronous machinery.

D-C Machinery. A meeting was held during the Chicago meeting and another during the midwinter meeting. The program for more accurate loss evaluation and temperature determination by test is proceeding, and recommendations incorporating the results of the program in various test codes and standards will be made. A carbon brush test code is in process under joint sponsorship of this and another committee.

Single-Phase and Fractional-Horsepower Machinery. This is a newly organized subcommittee. The committee plans to study the proper scope of its activities as co-ordinated with other subcommittees, the preparation of test of codes, and the submission of recommendations for standards.

Insulation. A meeting was held at the winter meeting at which time a preliminary draft of the proposed Standards on insulation resistance of d-c machinery was discussed. It was decided to rewrite completely AIEE Standard 43 to include d-c machinery.

Following the submission of these reports, the main committee discussed them and other business. The scope of the insulation subcommittee was broadened from its previous activity of insulation resistance to cover all proper types of activity on rotating machinery insulation. The main committee was informed of and approved an ambitious program to prepare an extensive bibliography on rotating machinery which would be submitted to the Institute as a basis for reference and for analysis of the published literature. The preparation of the application guides by the rotating machinery committee was deemed undesirable, however co-operation with industry committees will be undertaken gladly should they desire such guides. Business pertaining to joint action between the rotating machinery and other committees was discussed with recommendations for action.

During the period up to April 30, 1948, the committee as a whole, through its subcommittees, has sponsored six technical sessions including a major motor program at the Middle Eastern District meeting at Dayton. In all, 33 technical papers have been sponsored at four major meetings. AIEE Standard 43 has been written. Report *43-A*, "Recommended Practice for Insulation Resistance Testing of Rotating Machinery," soon will be ready for submission. Plans have been made for sponsoring a major rotating machinery meeting during the coming year.

COMMITTEE ON SYSTEM ENGINEERING

This committee is a new technical committee established by the reorganization of the technical committees of the power group for this year. In view of this, a completely new committee organization had to be set up. There was no committee work or investigations carried over from the previous year as is the usual case with standing committees. In the formation of the committee, a definite attempt was made to secure as country-wide representation as possible and this also was carried out in the establishment of the subcommittees. There were six subcommittees established as follows: administrative, system planning, system operations, system economics, system controls, and interconnection contracts.

The scope for the system engineering committee was reported in the October 1947 issue of *ELECTRICAL ENGINEERING.* The membership and scopes of the subcommittees were given in detail in the January 1948 issue of *ELECTRICAL ENGINEERING.*

The first meeting of the system engineering committee was held on November 5, 1947, in Chicago, Ill., during the Midwest general meeting with 18 members or their representatives in attendance. The scopes and memberships of all the subcommittees were given a final review and assignments were made to the individual subcommittees as to investigations and solicitation of papers for future AIEE meetings.

A second meeting of the system engineering committee was held on January 29, 1948, in Pittsburgh, during the winter general meeting with 21 members and guests present. At this time the individual subcommittees reported as to their work and their plans in progress. Plans were made for solicitation of papers for presentation at the Midwest general meeting in the Fall of 1948. It was announced that a joint subcommittee had been appointed on the "application of probability methods to capacity problems." This is to be a joint subcommittee with the power generation committee.

A general system engineering session was sponsored at the winter general meeting in Pittsburgh, at which five conference papers were presented. The first of these was on the timely subject "Electric Power and Our National Defense." The other four conference papers were a symposium on the "Controllable Factors Affecting System Loads." These were believed to be of importance in view of the tight capacity conditions existing throughout the United States at present.

A special subcommittee has been established under the sponsorship of the switchgear committee to investigate "high-voltage switching where out of phase voltages exist at time of arc interruption." The system engineering committee, together with the power generation, relay, and transmission and distribution committees, is providing for representation on this working subcommittee.

At the time of rendering this report, the several subcommittees have in preparation technical papers for at least two and probably three full sessions at the Midwest general meeting in Milwaukee, October 18–22, 1948.

The system controls subcommittee is preparing a questionnaire to be sent to operating companies to summarize the status of load-frequency control equipment and its use on the various individual and interconnected systems. It is expected that this report will be available for the Milwaukee meeting.

COMMITTEE ON TRANSMISSION AND DISTRIBUTION

Since the reorganization of the technical committees and reallocation of scopes, three meetings of the transmission and distribution committee have been held, the first on December 5 in Chicago, the second on February 25 in Cleveland, the third on May 28 in New York. The meetings were well attended. Following the formal meeting in Cleveland a general discussion organized previously by the lightning and insulator subcommittee was held on the subject of insulator contamination. Two prepared discussions were presented after which a general discussion followed.

Technical Meetings. Two technical sessions were sponsored by the transmission and distribution committee at the Midwest general meeting at which papers dealing with the Tidd 500-kv project were presented. A joint session at this meeting also was sponsored by the transmission and distribution committee. At the winter general meeting a session dealing with the Duquesne Light 10,000-kva series capacitor was sponsored. Two technical sessions sponsored by the transmission and distribution committee are being held at the Mexico City meeting.

Capacitor Subcommittee. The capacitor subcommittee is engaged in the revision of AIEE Standard 18 on capacitors. A final draft of the proposed Standard will be completed this year. This subcommittee also is concerned with operating procedures and application requirements for capacitors and is investigating troubles that have occurred with capacitors.

Distribution Subcommittee. The principal activity of the distribution subcommittee was concerned with the preparation of a report entitled "Distribution Design Practices and Trends," to be presented at the summer general meeting. This subcommittee also has in mind the organization of a symposium during the 1949 winter general meeting on the "Operation of Primary Network Systems." Consideration also is being given to the question of sag data for distribution conductors.

General Systems Subcommittee. The general systems subcommittee has completed a report on "Power System Recovery Voltages." A working group of this subcommittee actively is engaged jointly with the lightning protective devices subcommittee of the protective devices committee in the determination of "the voltage recovery of typical distribution circuits."

Lightning and Insulator Subcommittee. This subcommittee has under preparation a report entitled "Recommendations for Lightning-Proof Lines." They also actively are sponsoring papers concerned with insulator contamination and corrective measures. A symposium on this subject is being organized for the Midwest general meeting. This subcommittee also is concerning itself with the development of additional data on 60-cycle and impulse flashover characteristics of disk-type insulator strings made up of between 20 and 30 units. This is for use in connection with transmission voltages in the range of ultrahigh voltages.

Towers, Poles, and Conductors Subcommittee. A report has just been completed by this subcommittee entitled "Conductors—Types, Availability, and Use," which will be presented at the summer general meeting. Other subjects being considered by this committee are the thermal limitations of conductors and clamps and radio interference emanating from corona.

Co-ordination with Edison Electric Institute. An effort is being made to engender closer co-operation between the transmission and distribution committee of the EEI and transmission and distribution committee of the AIEE. To this end a proposal is being considered to have mutual representation of responsible officers on the respective committees. A striking example of this co-operation is the organization of the subject committee on line outages of the transmission and distribution committee of the AIEE, in which the EEI committee will be represented officially by a member. The function of this committee is to collect information on various phases of line outages. The EEI representative will report the progress of the EEI committee and operate in a general liaison capacity. Similarly, with regard to the study being made by the capacitor subcommittee with relation to capacitor troubles, Howard Stites is the EEI representative on this committee work.

Industry Group

COMMITTEE ON CHEMICAL, ELECTROCHEMICAL, AND ELECTROTHERMAL APPLICATIONS

The committee held one general meeting during the year, in Pittsburgh, January 1948. The accomplishments of the past calendar year were reviewed and plans discussed for the coming year.

A new subcommittee on chemical industries was formed and some personnel appointed. The scope of this subcommittee is to cover the interests of the chemical industry exclusive of electrolytic or electrothermal processes.

It is believed that this technical committee now is organized logically into its functional subcommittees, and personnel and chairmen have been secured. The subcommittees now are functioning.

This technical committee consists of the following subcommittees:

1. Electrolytic processes
2. Batteries, battery forming, and charging
3. Arc furnaces and electrothermal processes
4. Metallic rectifiers
5. Petroleum refining and production
6. Cathodic protection
7. Chemical industries

The special subcommittee on voltage transients in arc furnaces has died without issue.

The following activities were engaged in during the year by the subcommittees:

1. *Electrolytic processes*

Held a conference on conversion equipment in the electrochemical industry in Montreal, June 1947. Conference papers published in booklet form together with formal papers sponsored by power electronics group.

Held a meeting of this subcommittee in Montreal and discussed future plans.

2. *Batteries, battery forming, and charging*

Held a conference on the care, maintenance, and charging of storage batteries in Chicago, October 1947. The meeting of the subcommittee discussed possible future activities and work that needs to be done.

3. *Arc furnaces and electrothermal processes*

Held a conference on electrothermal processes in Pittsburgh, January 1948. Several of these conference-type papers are being prepared for publication.

4. *Metallic rectifiers*

A subcommittee meeting was held on October 11, 1947, in New York to discuss plans for the 1948 winter general meeting.

Held a conference in Pittsburgh, January 1948, with one formal paper and five conference-type papers. The subcommittee also held a committee meeting to discuss Standards for metallic rectifiers and to plan future activities. The proposed Standard for metallic rectifiers was published for comments and criticism on August 1, 1946; revised December 2, 1946, April 18, 1947, June 9, 1947, and July 1947.

5. *Petroleum refining and production*

While no formal meeting of the subcommittee yet has been held, two formal papers are being sponsored for the Mexico City meeting.

COMMITTEE ON ELECTRIC HEATING

The board of directors authorized in January 1947 the formation of a technical committee on electric heating. During the past year this committee has been organized and its work initiated with the assistance of several subcommittees. These subcommittees include the following: electronic heating, radiation measurements above 200 megacycles, resistance heating and electric furnaces, and radiant heating. The first meeting of the electric heating committee was held on January 27, 1948, in connection with the 1948 winter general meeting. The committee sponsored a session at this meeting on electronic and resistance heating.

The work of the subcommittee on electronic heating on interfering radiations from induction and dielectric heating equipment has been continued. Upon the advice of this subcommittee the Federal Communications Commission has promulgated rules and regulations regarding interference from such equipment. A working group of the subcommittee now is engaged in studying the matter of good engineering practice in the case of interference. Another working group has initiated the preparation of Standards on induction and dielectric heating. Because of the interest of Institute of Radio Engineers and National Electrical Manufacturers Association in these matters it was thought advisable to form a joint co-ordination committee to distribute the work among the committees of the various interested societies. This committee is known as the joint AIEE, IRE, NEMA co-ordination committee on commercial induction and dielectric heating apparatus. The AIEE representative on this committee is the chairman of the electric heating committee.

The subcommittee on radiation measurements above 200 megacycles has studied equipment and methods for measurement of radiation in the frequency range from 200 megacycles to 20,000 megacycles. This work, of course, is in preparation for the extension of dielectric heating into this frequency range. The techniques and equipment used for such measurements differ widely from those employed at lower frequencies, so that much original work has been required which eventually will be presented to the members of AIEE in papers.

The subcommittee on resistance heating and electric furnaces held its first meeting in connection with the 1948 winter general meeting of AIEE. It plans active participation in a program to stimulate and standardize this form of heating in industry.

The subcommittee on radiant heating held its first meeting in February 1948. It plans an unusually large program covering the following: historical, methods of temperature measurement, Standards, coatings for infrared baking, patents, energy distribution, control equipment and safety, research, and Student Branches.

COMMITTEE ON INDUSTRIAL CONTROL

The scope of this committee has been broadened to include design, construction, and performance of industrial control equipment. Some progress has been made in increasing the number of industrial engineers in the membership of the committee.

The subcommittee on Standards actively is engaged in the revision of the present AIEE industrial control Standard in co-operation with the corresponding committees of American Standards Association and NEMA. A revised draft of the Standard soon will be ready for the Standards committee.

The subcommittee on electronic control has had an active year organizing its various working groups with a view to preparing circuit and component definitions associated with industrial electronic control. This subcommittee is represented on the committee on electronics and its work is being correlated closely with the more general committee. The working groups have defined their objectives which, when completed, should extend the usefulness of the present AIEE Standard on Industrial Control.

The subcommittee on test codes is proceeding with one or two projects which are part of an over-all program established during the year.

The bibliography continues to grow, and it is hoped that before long a completely indexed bibliography of extensive proportions will be available for publication.

The joint subcommittee on servomechanisms continues to act under the joint sponsorship of the committees on basic sciences and instruments and measurements. An interesting session was held at the winter general meeting. The activities of the subcommittee on electronic control is being correlated with this joint subcommittee to prevent overlapping. It is hoped that the joint subcommittee will sponsor more papers illustrating the application of servomechanism theory to industrial problems.

During the year the committee has been very actively engaged in soliciting papers. One session was sponsored at the 1947 summer general meeting, one at the Midwest general meeting, and two on steel mill applications at the winter general meeting, and another on wire drawing machinery at New Haven in April 1948. The sessions were well attended and brought considerable discussion from the membership.

Communication and Science Group

COMMITTEE ON COMMUNICATION

The communication phase of electrical engineering as practiced today covers a very broad and continually expanding activity. The committee on communication is constantly on the lookout for papers of interest to the specialist in communications, as well as papers of general interest to the electrical engineer. Special attention has been given to papers on radiobroadcasting and home receivers. Several sessions are being scheduled at the 1948 Midwest general meeting covering these subjects.

Full sessions were sponsored by the committee at all of the general meetings. Two sessions composed of eight papers were sponsored at the summer general meeting in Montreal. One session included papers on modulation, and the other the general subject of communication. At the 1947 Pacific general meeting held in San Diego, two sessions composed of 11 papers were sponsored by the committee. The papers covered the fields of communication, electronics, and Sonar. Two sessions composed of eight papers covering general and special communication subjects were presented at the Chicago Midwest general meeting. An extra effort was made at the Pittsburgh winter general meeting to highlight communication subjects. As a result, five sessions composed of 17 papers covering communication components and techniques, magnetic recording, synthetic crystals, facsimile, and radio relay systems were presented.

As the current fiscal year draws to a close, plans have been finalized for a 4-paper session at the Mexico City summer meeting and a 4-paper session for the Spokane general meeting. A 20-paper 5-session program is in the preliminary planning stage for the Milwaukee Midwest general meeting.

Papers solicited and reviewed by the committee are available for use at District meetings. Two requests for communication papers were received from Districts during the current fiscal year.

During the year 21 papers and reports sponsored by the committee were published in *ELECTRICAL ENGINEERING* or in *TRANSACTIONS*. Many more have been recommended for future publication.

Starting in August 1947, the committee on communication was reorganized. Nine subcommittees were appointed and cover the following fields:

1. Wire communication systems.
2. Radio communication systems.
3. Radiobroadcasting systems.
4. Communication switching systems.
5. Power line carrier systems.
6. Home radio receivers.
7. Record communication.
8. Special communication application.
9. Communication standards.

The subcommittee chairmen, committee chairman, vice-chairman, secretary, and junior past chairman, have composed a co-ordinating committee to direct, in general, the subcommittee activities and take final action on matters referred to the committee for attention. Two general meetings of the whole committee and three meetings of the co-ordinating committee have been held during the current fiscal year. The purpose of the foregoing reorganization is directed toward communication group status with full committee responsibility for the present subcommittees.

COMMITTEE ON COMPUTING DEVICES

The committee on computing devices was newly formed in January 1948. Most of the work has been as a subcommittee of the basic sciences committee. (There was a conference at Montreal, and a few papers published in *ELECTRICAL ENGINEERING*.)

The only committee activity has been organizational, that is, to appoint a vice-chairman (Doctor J. G. Brainerd) and a secretary (Professor W. C. Johnson), and to form two subcommittees, one on digital computers (Doctor J. W. Mauchly, chairman), and one on continuous-variable computers (Doctor E. L. Harder, chairman).

COMMITTEE ON BASIC SCIENCES

The committee on basic sciences occupies a unique position in the activities of the Institute. Its function is to advance the theory of electrical engineering and of the allied arts and sciences in all of their branches; consequently, efforts have been, and are being made, to assist the several other technical committees wherever such action is desired. Specific examples which may be mentioned are: the initiation of nucleonic studies by the subcommittee on energy sources, which subject subsequently was taken over by the full technical committee on nucleonics; formation of a joint subcommittee on servomechanisms, with the committees on instruments and measurements, and on industrial control devices; subcommittee on large scale computing devices, recently transformed into a full technical committee on computing devices; liaison members on subcommittees of the committees on electrochemistry and electrometallurgy, on systems engineering, and on power generation.

The subcommittee method of operation of the committee on basic sciences has proved to be highly successful during the past two years of its operation. It had been suggested by the preceding chairman of the committee during the war, but military restrictions at that time limited the activities of the committee, causing postponement of the program.

During the past year, the committee and its several subcommittees have held sessions, conferences, and symposia in their respective fields, as follows:

Summer General Meeting (Montreal), June 1947

1. Participation in conference on technical group activities in the Sections.
2. Session on servomechanisms.
3. Conference on large scale computing devices.

Midwest General Meeting (Chicago), November 1947

1. Conference on energy sources.
2. Session on basic sciences.

Winter General Meeting (Pittsburgh), January 1948

1. Session on basic sciences.
2. Conference on applied mathematics.
3. Symposium on electrical network theory.
4. Session on servomechanisms (combined with measurements).

The interest shown at these meeting, has been quite gratifying, in most instance, being among those sessions having the largest attendance at the technical meetings.

Four subcommittees have been in active work during the past year. These are: electric circuit theory, energy sources, applied mathematics, and large scale computing devices. As mentioned, the subcommittee on large scale computing devices has become a full technical committee, retaining the same personnel as that of the subcommittee. Two new subcommittees have been formed in the past few months, and a third is planned. Those now underway are the subcommittees on electrical properties of solids and on magnetics. The third is to be the subcommittee on electrical properties of liquids and gases. It is expected that these new subcommittees will be in a position to conduct conferences in their respective fields, beginning with the 1949 winter general meeting of the Institute.

As a number of the committee members also are members of subcommittee 1 of ASA sectional committee *C-42*, "Definitions of Electrical Terms," it is planned to establish definitions of fundamental and derived terms which are acceptable to the engineering profession as a whole. The committee on basic sciences will provide the desired reviewing body for this work.

As it is extremely difficult to hold committee meetings at frequent intervals, because of the wide dispersion of the membership, it has been the practice to hold committee meetings in connection with the general meetings of the Institute. The attendance at these meetings has been very good, which along with the correspondence among members, has enabled the committee to function quite efficiently.

COMMITTEE ON ELECTRONICS

The committee has continued the policy of subcommittee rotation, that is, of forming and disbanding, as needs require, subcommittees in various fields of electronic design and application. The purpose of this policy is to insure active AIEE contact and support in all areas of the expanding electronic arts; it calls for occasional upgrading of major subcommittees to the status of technical committees of the Institute.

There are two types of subcommittees within the committee organization. One type serves to expedite general functions, including: processing of Standards; papers solicitation and aids to Sections; maintenance of nation-wide and international informational contacts; education; and liaison with other professional groups. The other type is responsible for attention to specific technical fields. The committee entered the year with five general-function subcommittees, and added three, thus closing the year with eight such groups. At the beginning of the present administrative year there were six subcommittees having specific technical activities; and five new ones were formed; thus the electronics committee closes the year with a total of 19 subcommittees of which number 8 are administrative and 11 are technical.

Plans of operation for the 1947–48 period were formulated at a meeting of subcommittee chairmen in New York City on

August 26, 1947. A meeting of the committee was held in Chicago on November 4, 1947, in connection with the National Electronics Conference, where procedures involved in establishing Standards were discussed in some detail. A meeting held at Pittsburgh on January 26, 1948, in connection with the winter general meeting, was devoted to reviews of plans for technical sessions, conferences, and papers, and to reports on the accomplishments of the various subcommittees during the year past.

At the 1947 summer general meeting in Montreal the committee sponsored a technical session, and a conference on rectifiers. The committee organized a technical session of the National Electronics Conference at Chicago on November 4. At the winter general meeting in Pittsburgh the committee sponsored a technical session, also a technical conference on, "Some New Electronic Devices and Methods," also, the committee shared with the rectifier committee the sponsorship of a conference on mechanical rectifiers. For the summer general meeting in Mexico City the committee has arranged two technical papers, and has assisted the committee on education in arranging a discussion of certain educational aspects of electronics.

Through the medium of the joint subcommittee on electronic instruments, the committee had an important share in the planning of the 2-day AIEE conference on electron tubes, held in Philadelphia, March 29 and 30. The objective of this conference was to study the problem of making generally available electron tubes meeting specifications needed for electronic instruments and related industrial electronic devices. This conference consisted of five technical sessions, the three on the first day being devoted to study of the factual background of the problem, and those on the second day to methods of meeting the existing needs. The conference was very well attended; there was active discussion; and it is believed the program was an important contribution.

During the calendar year 1947, *ELECTRICAL ENGINEERING* contained a very large proportion of articles including important electronic material. The activities of the committee and its subcommittees have contributed substantially to this result.

Activities of the subcommittees of the general-function type are reported in the following.

Electronic Papers Solicitation and Section Contacts. This subcommittee continually has solicited technical papers from the other subcommittees. It has provided a convenient channel for originating and selecting suitable papers, and for organizing technical sessions relative to all fields of electronic application. This subcommittee sponsors annually at the winter general meeting a conference on new electronic devices and methods. Active encouragement has been given to other technical committees of the Institute to sponsor electronic papers at appropriate technical sessions.

Sections of the Institute have been aided materially by this subcommittee's activity in providing films, speakers, and technical information on electronic subjects.

Standards. This subcommittee keeps the committee members informed as to standardizing procedure, also as to the progress of specific standard proposals, and serves as a channel for processing Standards. It is at present active in attempting to establish a uniformity between American Standard symbols and those recommended by the Patent Office, in regard to electronic diagrams. This subcommittee is maintaining contact with certain IRE committee activities of importance in regard to Standards in radar and frequency designation.

Liaison With IRE. It is essential to maintain proper contact and co-ordination of committee activity between various professional groups active in electronic matters. It is this subcommittee's responsibility to maintain an awareness of co-ordination needs, particularly relative to the IRE.

Liaison With Joint Electron Tube Engineering Council. It is important that the committee be kept informed of the needs and interests of the JETEC in matters of policy, co-ordination as to area of standardization, and so forth. This liaison has been provided by the subcommittee on liaison with JETEC.

Liaison With Nucleonics. Most of the instruments and apparatus employed in neucleonics are electronic in character. This liaison committee was formed to keep the electronics committee informed of the work of the neucleonics committee.

Electronic Developments Abroad. This subcommittee has prepared a survey report of recent progress in power electronics in several European countries, including extracts from extensive foreign reports received in reply to the subcommittee's inquiries. The information relative to new uses of d-c transmission is of special interest. This report should appear in an early issue of *ELECTRICAL ENGINEERING.*

Education in Electronics. This newly-formed subcommittee will acquaint the committee with progress and problems related to rapidly changing requirements for education in the electronic areas of electrical engineering, and co-ordinate the committee's activities with those of the AIEE committee on education.

West Coast Subcommittee. This newly-formed subcommittee will be concerned with securing papers of electronic interest from the West Coast area, particularly for meetings in that area, and with stimulating active participation from that area in AIEE technical committee work, where electronic problems are involved.

The activities of subcommittees working in specific technical fields may be summarized as in the following:

Electronic Instruments. The joint committee on electronic instruments completed its survey of special tube needs for instrumentation purposes, and organized the afore-mentioned 2-day tube conference. Participation in this survey and conference activity has been one of the most important contributions of the committee on electronics during the past year. This activity is being continued. Five technical papers and three conference papers were obtained for the Pittsburgh meeting by this subcommittee; the technical papers are being processed for publication. A program of Standards work in the electronic instrument field is being formulated.

Electron Tubes. The scope of this subcommittee is the treatment of all appropriate technical matters relating to the design, construction, test, and operation of electron tubes for industrial use, including the preparation of Standards, papers, and reports, and the promotion of meetings and conferences dealing with electron tubes and their uses. All classes of electron tubes important for industrial use are included in the intent of this scope.

Four working groups have been organized to give immediate attention to the preparation of Standards for tubes used industrially. The working groups deal respectively with high vacuum tubes, cathode-ray tubes, gas-filled tubes and photoelectric tubes, and mercury-pool tubes. The initial meetings of the various working groups were held during the early months of 1948.

Electronic Aids to Medicine. This subcommittee is planning a 2-day conference, to be held in New York City in the Fall of 1948. Arrangements are being set up to attract both engineering and medical personnel, in order to promote a better understanding by engineers of the engineering problems peculiar to biological practice, and by medical personnel of possible engineering approaches to biological practice. Subjects discussed at the conference will include biological amplifier and recording device requirements, practice in biological stable isotope measurements, and present practice in biological radioactivity measurement.

Electronic Aids to Navigation. This subcommittee operates jointly with an IRE committee on the same subject. This group has compiled a set of more than 200 basic definitions of radio navigation terms which currently are being compared, for purposes of mutual revision, with a set of similar definitions by the Radio Technical Commission for Aeronautics.

High-Frequency Conductors, Cables, and Connectors. The scope of this subcommittee is to give attention to Standards, papers procurement, and so forth, to the developing needs for adequate handling of power and signals in high-frequency coaxial and wave guide circuit elements, including problems of heating, reflection, and impedance characteristics.

Hot Cathode Converters. This subcommittee has completed its immediate Standards program on definitions, except for the adjustment of a few inconsistencies between American Standard Definitions and proposed Standards for mercury arc power rectifiers and for metallic rectifiers. The committee now is compiling a list of circuits to be included in the Standards. The committee is endeavoring to procure technical papers which will clarify existing uncertainties as to test code basis in hot cathode rectifier equipment in which transformer reactance is important.

X-Ray Tubes and Apparatus. This committee recently has been reorganized, to broaden its scope. This group currently is reviewing recently proposed Standards, and is studying means of specifying X-ray and associated rectifier tube characteristics and ratings. Arrangements have been made for co-ordination of the Standards activity with the work of NEMA and Radio Manufacturers Association groups having similar interests.

Electronic Precipitation. This subcommittee is planning papers for a technical session on electronic precipitation equipment, with a later one in prospect relative to electrostatic phenomena in industry.

Electronic Aids to Geophysics. The immediate objective of this recently formed subcommittee will be to give AIEE support to efforts being made, by co-ordinated technical societies in the oil-producing geographical area, toward broader publicizing in technical periodicals of the many recent important developments in this field of interest.

Infrared Applications. This subcommittee has been very recently formed, and is at present making a study to outline its scope and immediate objectives.

Electronic Preparation and Preservation of Food. This subcommittee's present status is the same as that on infrared applications.

The committee, as a whole, is attempting to maintain a vigorous outlook to insure adequate coverage of the various fields in which electronics is becoming of importance in science, industry, and government.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

The activities of this committee have been directed toward the fostering of interest, the co-ordination of effort, and the development of Standards in the field of measurements which underlies so much of the technical activity of the Institute. To secure adequate representation in some of the newer phases of measuring activity, and provide closer liaison with other technical committees, the membership of the committee was expanded to 41. Meetings of the main committee were held on October 21, 1947, and March 16, 1948, and there have been numerous meetings of subcommittees.

A total of 25 technical papers sponsored by the committee were presented during the year, and most of these are being published. These papers cover a wide range of subject matter, including: fundamental analyses of measuring methods; microwave frequency measuring devices, methods, and Standards; new types of telemetering systems; oscillograph and oscilloscope techniques; industrial electronic instruments for steel processing; laboratory measuring standards; d-c amplifiers and other electronic circuits; nucleonic instrumentation; calorimetric measurements; characteristics of recording instruments; optical radar; supersonic devices; instrument characteristics; recording of sea water characteristics.

The committee sponsored two technical sessions at the winter meeting and was joint sponsor for three others. Additional papers were presented at the Great Lakes and North Eastern District meetings.

A large part of the work is carried out through nine subcommittees.

Subcommittee on Revision of Standard 4 (Measurement of Test Voltage in Dielectric Tests). A working group is drawing up a specification for measurements of surge voltages at intervals from 0.1 to 1 microsecond. Additional material is being prepared on other measuring methods.

Subcommittee on Revision of C39 (Electric Indicating Instruments). This subcommittee is co-operating with the ASA subcommittee on a complete revision of the *C39* standard. The work on panel-type and switchboard instruments is substantially complete and will be presented for approval at an early date. Consideration of portable instruments and laboratory Standards will follow.

Subcommittee on Master Test Code for Resistance Measurements. A proposed new code was published in September 1947 for one year's trial use. Comments are being collected.

Subcommittee on Master Test Code for Temperature Measurements. At the suggestion of the Standards committee, a proposed new code has been circulated for comment. It now is being presubmitted with the recommendation that it be printed for trial use.

Subcommittee on Marking of Varmeters and Related Instruments. A questionnaire is being circulated to determine types of instruments and their markings.

Subcommittee on Watt-hour Meters. Activities were limited to minor standardization matters.

Subcommittee on Electrical Tests on Dielectrics in the Field. A general report and bibliography on this subject are being prepared. A technical conference is planned for the Milwaukee meeting in October 1948.

Subcommittee on High-Frequency Measurements. The field of this subcommittee includes all frequencies above the audio range, with special emphasis on the higher radio frequencies where the more recent developments in the art are found. A technical session was sponsored at the winter meeting. A symposium is planned under the joint sponsorship of AIEE, IRE, and Bureau of Standards.

Subcommittee on Definitions. A large number of definitions prepared by this subcommittee have been transmitted to appropriate subcommittees of ASA *C42*. Definitions prepared by Subcommittee 6 of ASA *C42* are being reviewed by this subcommittee.

Close relationship and co-operation with other technical committees is fundamental to the work of the committee on instruments and measurements. Co-ordination is maintained by a number of joint subcommittees, and in other cases by cross representation. During the year, one new joint subcommittee was formed to centralize all Institute work on instrument transformers. This is under the direction of the instruments and measurements committee and the transformer committee, with representation also from the switchgear committee, the relay committee, the transmission and distribution committee, and the carrier current committee. For better co-ordination, the chairmen of all the standing joint subcommittees have been made members of the instruments and measurements committee.

Joint Subcommittee on Electronic Instruments. This subcommittee completed its survey of the needs and requirements for improved electron tubes for industrial instrumentation and control. A 2-day conference was held at Philadelphia to present the results of the survey and outline a program for obtaining improved tubes. A registration of 281 attested to the success of this conference. Contributing largely to this success was the community of interest in the subject. The conference has given a needed impetus to improved tubes for industrial usage, and should have important results in future. Moreover, it has established a pattern which other committees are planning to follow.

Joint Subcommittee on Servomechanisms. This subcommittee has been reorganized. Two technical papers were presented at the winter meeting.

Joint Subcommittee on Nucleonic Instruments. A conference session on instruments for radiation measurement was sponsored at the winter meeting, and similar sessions are planned in August and October. A paper on "Methods of Protection and Measurement of Nuclear Radiation," was published.

Joint Subcommittee on Telemetering. The October 1941 report on telemetering, supervisory control, and associated circuits is being revised. A technical session was sponsored at the winter meeting.

Joint Subcommittee on Instrument Transformers. This newly formed subcommittee has organized working groups to handle activities on current transformers, test code, and rating factors. That part of the new Standard ASA *C57* which deals with instrument transformers is being published separately by the AIEE.

Joint Subcommittee on Standard Frequency Bands and Designations. A proposed table of standard frequency bands was published in *ELECTRICAL ENGINEERING.*[6] Co-ordination with IRE, looking toward an ASA Standard, now is required.

COMMITTEE ON NUCLEONICS

Three meetings of the committee were held—one each in Montreal, Chicago, and Pittsburgh. At the Chicago meeting, the committee sponsored a talk by Doctor Enrico Fermi on the "Future of Atomic Power." The Des Moines District meeting had one session with four papers devoted to the subject of particle accelerators. The Pittsburgh meeting had a session of five conference papers on nucleonics instruments.

A series of papers on nucleonics were sponsored by the committee for publication in *ELECTRICAL ENGINEERING* as follows:

1. "The Atom and Its Nucleus," J. J. Smith (*EE, Dec '47, pp 1165–75*)
2. "The Relation Between Energy and Mass," Frederick Seitz, Jr. (*EE, Jan '48, pp 1–5*)
3. "The Nucleus—Its Structure and Reactions," W. E. Shoupp, Hugh Odishaw (*EE, Feb '48, pp 125–34*)
4. "Nuclear Engineering," E. U. Condon (*EE, Mar '48, pp 229–32*)
5. "Detection and Measurement of Nuclear Radiation," G. Wesley Dunlap (*EE, Apr '48, pp 325–32*)
6. "The Separation of Isotopes," G. Wesley Dunlap, R. M. Lichtenstein (*EE, May '48, pp 469–74*)
7. "Cascades Used in Isotope Separation," Harold C. Urey (*EE, Jun '48, pp 581–6*)
8. "Nuclear Reactors," F. L. Friedman (*EE, Jul '48, pp 685–93*)
9. "High-Energy Particle Accelerators," J. R. Woodyard (*EE, Aug '48, pp 759–67*)

The following articles are planned to complete the series:

10. "Physical and Medical Aspects of Radiation Hazards and Protection," L. L. German, H. M. Rozendaal
11. "Isotopic Tracers," J. T. Wilson
12. "Nuclear Reactors for Power Generation," W. F. Davidson

The purpose of this series is to furnish members of the Institute with an over-all picture of recent developments in nucleonics and allied fields. It is planned to issue these articles in booklet form when the series is complete.

Jointly with the instruments and measurements committee of the Institute, a subcommittee on nucleonic instruments and controls was set up with Doctor G. W. Dunlap as chairman. This committee has held three meetings. It sponsored the session on nucleonics instruments referred to in the foregoing at the Pittsburgh meeting. It is planning additional sessions at the Washington and Spokane meetings.

Recently two additional subcommittees have been set up—one on nuclear physics with J. T. Wilson as chairman, and one on isotopic tracers with W. E. Barbour as chairman.

Another subcommittee on health safety is being planned jointly with the AIEE committee on therapeutics.

There is considerable activity not only in AIEE, but also in other professional organizations with regard to the development of a glossary of nuclear terms. This activity is being followed by the committee as it is desirable that such a glossary fill the needs in the various other technical fields, in addition to that of electrical engineering.

General Applications Group

COMMITTEE ON AIR TRANSPORTATION

The committee on air transportation held one meeting of the entire committee during the administrative year. This meeting was held in Dayton, Ohio, on September 26, 1947, following the Middle Eastern District meeting. At this meeting the Standards activities of the air transportation committee for the coming year were discussed and plans were made for technical sessions at future AIEE meetings.

The wide geographical spread of the aircraft industry has made active participation of interested groups in committee activities very difficult in the past. However, it is believed that this problem partially has been solved by the encouragement of the activities of air transportation divisions of the local Sections. In this way air transportation members may represent more effectively the majority opinion of the aviation industry when attending committee meetings.

Due to changes in personnel, the work of the committee and its subcommittees has been delayed to some extent. However, effort has been made to carry on the Standards program of the committee and to initiate new Standards to meet the requirements of the industry. The status of the committee's work is described under the heading of its several subcommittees as given in the following paragraphs.

Aircraft Electric Systems. This subcommittee has prepared the "Report on Aircraft Electric System Guide," AIEE 750, which was published in July 1947. The "System Guide" was issued with some sections incomplete with the aim of adding the unfinished section as soon as the material is available. At the present the subcommittees are co-operating in compiling information for the incomplete sections, which information will be correlated by the aircraft electric systems subcommittee and submitted to the Standards committee for inclusion in the "guide." In its present form the "System Guide" contains considerable valuable information which will be helpful to the designers and operators of aircraft electric systems. To increase the general acceptance of standard practices in aircraft electrical engineering it is desirable that the "System Guide" have a wider dissemination.

Aircraft Electric Rotating Machinery. The "Proposed Test Code for D-C Aircraft Machines," AIEE report 800, was issued March 1947 for one year's trial use. At the present a survey is being conducted to determine the extent of revisions and additions desirable in this proposed Standard, and to determine the recommendations of the air transportation committee to the Standards committee for its publication as an AIEE Standard.

This subcommittee at present is engaged in a project to formulate a new Standard on "Rating Standards of D-C Aircraft Generators." It is expected that a preliminary draft of this Standard will be ready for review by the air transportation committee by the end of 1948.

Aircraft Electric Control Protective Device and Cable. This subcommittee has been given the following assignment:

1. Prepare a test code for circuit interrupting devices.
2. Prepare test code for voltage regulators.

To date the first draft of "Proposed Test Code for Aircraft Circuit Interrupting Devices (12- and 24-volt d-c systems)" has been submitted to the subcommittee members for consideration and discussion. It is expected that this soon will be submitted to the Standards committee with recommendation that it be issued as a proposed test code for one year trial.

A working group has been appointed by the subcommittee to prepare a test code for d-c carbon pile voltage regulators. This working group has held three meetings and is scheduled to meet again in July 1948, at which time it is expected that a preliminary draft of the proposed test code will be presented for the consideration of and discussion by the group.

Basic Principles of Altitude Ratings. This subcommittee is preparing an AIEE Standard on the basic principles of altitude rating of electric machinery. The subcommittee has held three meetings and has compiled considerable information on environmental condition of altitude up to 50,000 feet. A survey is being conducted to determine the correlation of data obtained in flight with that obtained in altitude chambers. The survey also is to include the recommendation of users of altitude chambers concerning the use and limitation of chambers.

Joint Subcommittee (Air Transportation and Electric Machinery) on Carbon Brushes. This subcommittee is engaged in preparing an AIEE Standard for the testing of carbon brushes and brush material. Working groups have been formed of the subcommittee members to carry on the necessary investigations and to formulate the several phases of the standard test code necessary for the evaluation of carbon brush material and the performance of brushes on commutators and collector rings. It is expected that a preliminary draft of this Standard will be available by the end of 1948.

The air transportation committee is co-operating with the A2 committee of the Society of Automotive Engineers on problems of mutual interest. Liaison has been established with the National Aeronautical Standards Committee and with the Committee on Aviation and Airport Fire Protection, and it is expected that mutual benefit to all parties will result from the greater co-operative effort to produce working Standards which will be useful to the aviation industry.

Plans are being made for several technical sessions on air transportation at the Middle Eastern District meeting to be held in Washington, D. C., on October 5, 6, and 7, 1948. The response to the request for technical papers on aircraft electric subjects has been very gratifying. Effort is being made to stimulate increased preparation of technical papers and it is expected that technical sessions will be planned for more than one AIEE meeting during the next year.

COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

The committee on domestic and commercial applications, during the war years, was quite inactive and the present committee has been attempting to stimulate interest in the form of papers and discussions in the very broad field covered by the scope of this committee.

During the past year a very successful symposium on the heat pump was held in conjunction with the winter meeting of the Institute and work is under way now for a symposium on automatic protection of domestic equipment at the next winter meeting.

A paper on the application of inherent overheating protective devices for motors is scheduled for presentation at the summer meeting and one or two papers for District meetings are contemplated. While this is, perhaps, a small amount of activity when the tremendous advances in appliances of all kinds are considered, it is hoped it will be the beginning of a greater recognition among engineers generally of the real contribution that is being made by the engineers working on smaller equipment and publicized heretofore primarily through acceptance by the public rather than by any knowledge of their work by their fellow engineers in other lines.

Several subcommittees of this committee that have been completely inactive have been discontinued on the theory that contributions from an engineering standpoint are the only real justification for the existence of subcommittees. An alert and active main committee is contemplated instead.

COMMITTEE ON LAND TRANSPORTATION

Two well-attended meetings of the committee were held during the past year; one in June 1947 in Montreal and one during the winter meeting in January 1948 in Pittsburgh. The following activities were discussed and organized at these meetings.

Technical Meetings. Three transportation sessions were held at the winter meeting. A symposium on railroad electrification included papers on cost reduction of power for electrification, conversion and transmission costs, overhead distribution costs, and electric locomotives with identical basic components. This session was unusually well attended and there was considerable interested discussion. A second session on heavy traction included papers on Great Northern Railroad motive power shunt capacitor installation on the New Haven, checking the integrity of high-speed train brakes, and speed responsive devices on Diesel-electric locomotives. The third session was on light traction and included papers on trolley coach distribution system, electric vehicles in city transit, new Chicago rapid transit cars, and a-c air conditioning for railroad passenger cars. These sessions were all very well attended. Two transportation papers are scheduled for the summer general meeting.

Subcommittee Activities. The subcommittee appointed to review AIEE Standard 16, "Standards for Electric Railway Control Apparatus," submitted an excellent report in June 1947. The committee voted to include in this Standard the electric portions of electropneumatic brakes. Representatives of two air brake companies now have been added to the subcommittee and a final report should be submitted in the near future.

The subcommittee engaged in gathering and tabulating heavy traction electrification data submitted questionnaires to the committee meeting in January and these questionnaires now are being duplicated and sent to the electrified railroads of the United States.

COMMITTEE ON MARINE TRANSPORTATION

Revisions of AIEE Standard 45 (Recommended Practice for Electric Installations on Shipboard), which is under the cognizance of this committee, have been completed.

The review of Standard 45 was completed in May 1947 and the results of the review were compiled, sorted to their appropriate heading, and referred to the committee's subcommittee chairmen for comparison with the existing Standard and further comments.

Subcommittee chairmen completed their work during the latter months of 1947 and submitted their comparisons and comments to the committee's editing subcommittee.

A meeting of the full committee was held February 27, 1948, at which meeting the work of the subcommittees was reviewed and with slight modifications, mutually agreed on, accepted.

A meeting of the committee's subcommittee chairmen was held April 15–16, 1948, with a representative of United States Coast Guard for the purpose of clarifying certain items of the proposed revisions.

Revision of Standard 45 in its final form has been prepared and submitted to the AIEE Standards committee for consideration.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

The committee on the production and application of light arranged for a program for the Midwest general meeting in Chicago, Ill., on Tuesday, November 5, 1947. Technical papers were presented covering modern sources of infrared, visible, and ultraviolet radiation.

To encourage the planning of meetings on the subject of the production and application of light in various Sections, a letter was sent to all AIEE Section chairmen asking for a report on the number and type of such meetings which had been conducted within recent years, and offering the assistance of the committee in arranging such programs should they be desired. A number of the Sections requested assistance in arranging these programs, and such requests were referred to a member of the committee in the general area from which the request originated.

The remaining activities of the committee consisted of the formulation and continuation of certain subcommittee activities summarized in the following:

Subcommittee on Nomenclature of Electronic Lamps. This subcommittee was formulated several years ago at the request of the committee on electronics to assist in the preparation of definitions in the field of electronics by formulating definitions of lamps of this type.

Subcommittee on Preferred Voltage Characteristics of Electric Circuits for Lighting. A report from the previous chairman recommended that this particular subcommittee be discontinued. A copy of the report in which this recommendation was made is being circulated to various members of the committee to determine whether or not this recommendation will be followed.

Subcommittee on Infrared Radiation. A subcommittee to deal specifically with the subject of infrared radiation has been formulated and a program set up whereby it will work in close co-operation with the subcommittee on radiant heating of the technical committee on electric heating.

Subcommittee on Ultraviolet Radiation. A similar subcommittee was formulated to cover the field of the production and application of ultraviolet radiation.

The latter two subcommittees are working on specific assignments connected with the preparation of papers covering their specific fields.

Awards

INSTITUTE PRIZES

Five Institute prizes and ten District prizes were awarded for papers presented during the calendar year 1947, and for graduate and undergraduate student papers presented during the academic year ending June 30, 1947. A number of the papers were of a high order and the choice between leading papers in the several classes of Institute prizes was very close, so that six other papers received honorable mention.

Changes in prize awards for technical papers were announced in *ELECTRICAL ENGINEERING*, December 1947, pages 1248–9. Although it is too early to observe the effectiveness of these changes at the time of writing this report, 17 Branch prizes already have been awarded for the academic year ending July 30, 1948. This is a new prize established, one for each Branch, consisting of $10 cash plus an allowance of seven cents per mile one way for the winning representative to attend the District Branch competition.

CHARLES LEGEYT FORTESCUE FELLOWSHIP

This fellowship, which provides an allowance of $500 a year or more for graduate study in electrical engineering, was established as a memorial to Charles LeGeyt Fortescue in recognition of his valuable contributions to the electric power industry.

For the academic year 1948–49, a fellowship in the sum of $1,000 was awarded to James B. Woodford, Jr., a student at the Carnegie Institute of Technology, who will continue at that institution in graduate study.

COMMITTEE ON MEMBERS-FOR-LIFE FUND

The Members-For-Life fund committee held no meetings. By correspondence, it reviewed the use of the restricted fund and made recommendations to be embodied in report to President Hull, for board consideration at the summer general meeting.

EDISON MEDAL

The Edison Medal for 1947 was awarded to Doctor Joseph Slepian, associate director of the Westinghouse Research Laboratories, "For his theoretical and practical contributions to power systems through circuit analysis, arc control, and current interruption," and was presented on January 28, 1948, during the winter general meeting. The addresses given in connection with the presentation appear in *ELECTRICAL ENGINEERING* for March 1948, pages 258–64.

The medal may be awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts. Awards are made by a committee of 24 members of the Institute.

LAMME MEDAL

The Lamme Medal for 1947 was awarded to A. M. MacCutcheon, past president of the Institute, who retired, in 1946, from the position of vice-president in charge of engineering, Reliance Electric and Engineering Company, Cleveland, Ohio, "For his distinguished accomplishments in the development of motors for industrial needs, notably in the steel industry." The presentation will be made on June 23, 1948, during the summer general meeting in Mexico City.

Awards of the medal may be made annually by a committee of nine members of the Institute for meritorious achievement by a member of the AIEE in the development of electric apparatus or machinery.

HOOVER MEDAL

The Hoover Medal is awarded periodically to an engineer for distinguished public service by a board representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, and AIEE. No award was made for 1947.

JOHN FRITZ MEDAL

The John Fritz Medal may be awarded annually for notable scientific or industrial achievements, by a board of award composed of representatives of the ASCE, AIME, ASME, and AIEE. The 1948 medal was awarded to Doctor Theodor von Kármán as a "creative leader, stimulating teacher, and wise counselor in engineering and physical research in the fields of the aeronautical and structural sciences, for his many applications of mathematical and physical theory to the sound solution of engineering problems."

WASHINGTON AWARD

The Washington Award for 1948 was made to Senator Ralph E. Flanders of Vermont, who is president of the Jones and Lamson Machine Company, Springfield, Vt. The award is made annually to an outstanding engineer, a citizen or resident of the United States, who ably has served human needs, and is administered by a commission representing the Western Society of Engineers, ASCE, AIME, ASME, and AIEE.

ALFRED NOBLE PRIZE

This prize was established in 1929 to perpetuate the name and achievements of Alfred Noble, past president of the ASCE and the Western Society of Engineers. It may be made to a member of any of the co-operating societies, ASCE, AIME, ASME, AIEE, or WSE, for a technical paper of particular merit accepted by the publication committee of any of these societies, provided the author is not over 30 years of age at the time of such acceptance.

Joint Activities

UNITED ENGINEERING TRUSTEES, INC.

This organization manages property and funds held jointly by the four Founder Societies, including the Engineering Societies Building, the Engineering Societies Library, and the endowment funds of the Engineering Foundation. It also acts as treasurer for the Engineers' Council for Professional Development.

An abstract of the annual report of UET for the year ended September 30, 1947, appears in *ELECTRICAL ENGINEERING*, February 1948, page 209.

ENGINEERING FOUNDATION

The Engineering Foundation, a department of United Engineering Trustees, was established in 1914 as a joint agency of the Founder Societies for "the furtherance of research in science and engineering."

As part of its program, the foundation supported 13 research projects during the year 1946–47. For the current year it is continuing the maintenance of nine of these projects, and has added eight new ones.

An abstract of the annual report for the year ended September 30, 1947, appears in *ELECTRICAL ENGINEERING*, February 1948, pages 210–11.

ENGINEERING SOCIETIES LIBRARY

The Engineering Societies Library, formed by combining the separate libraries of the ASCE, AIME, ASME, and AIEE, is conducted as a free public reference library.

Total resources of the library presently include 164,051 volumes, 10,316 maps, and 4,943 searches. The library also renders special services such as translations, photoprints, bibliographies, and book loans by mail.

An abstract of the annual report for the year ended September 30, 1947, appears in *ELECTRICAL ENGINEERING*, February 1948, pages 209–10.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The principal activities of ECPD include "programs for the guidance of young persons thinking of entering the engineering field, the accrediting of curricula of engineering schools, encouragement and assistance to individuals in their engineering and cultural studies during several years following graduation, and the development of criteria for indicating the attainment of the status of an engineer." The council represents the national societies of chemical, civil, electrical, mechanical, and mining and metallurgical engineers. The Engineering Institute of Canada, the American Society for Engineering Education, and the National Council of State Boards of Engineering Examiners.

A report of ECPD's activities during the year 1946–47 is included in the annual report of the Engineering Foundation (*EE, Feb '48, p 211*).

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC.

Operating as an incorporated nonprofit organization, the Engineering Societies Personnel Service, Inc., assists members of the Founder Societies desiring to secure new positions and employers searching for engineers. Nonmembers may receive such assistance when positions available cannot be filled by members.

Offices are operated in New York, N.Y.; Detroit, Mich.; Chicago, Ill.; San Francisco, Calif.; with the co-operation of the Engineering Society of Detroit in that city, the Western Society of Engineers in Chicago, and the Engineers Club of San Francisco in that city.

ENGINEERS JOINT COUNCIL

This council, formerly known as the joint conference committee, is composed of the presidents, immediate past presidents, and secretaries of the Founder Societies and the AIChE. Its functions are to consider matters of interest to the societies and to make recommendations to their governing bodies.

REPRESENTATIVES

A complete list of about 40 joint bodies upon which the Institute is represented appears in the Year Book and in the October issue of *ELECTRICAL ENGINEERING* each year.

Appreciation

The board of directors acknowledges with appreciation and thanks the splendid co-operation received from Institute committees, District, Section, and Branch officers, and the membership.

Respectfully submitted for the board of directors.

H. H. HENLINE
Secretary

Official group of AIEE national officers and local representatives, acting as a special guard of honor, placed a memorial wreath at the Perpetual Flame in the base of the Monument to the Heroes of the Mexican Independence, June 22, 1948, during the 1948 AIEE summer general meeting. Left to right: Director J. M. Flanigen of Atlanta, Ga.; Vice-President E. W. Davis of Cambridge, Mass.; Director J. F. Fairman of New York City; Vice-president J. H. Berry of Norfolk, Va.; Vice-President C. F. Terrell of Seattle, Wash.; Past-President J. Elmer Housley of Alcoa, Tenn.; Jorge Rivera S. of the hospitality committee; Hector Martinez D'Meza, vice president of the summer general meeting committee; Secretary H. H. Henline of New York; Oscar R. Enriquez of Mexico City, president of the summer general meeting committee; AIEE President Blake D. Hull of Dallas, Texas; Manuel M. de Lascurain of Mexico City, member of the executive group of the summer general meeting committee; AIEE President-Elect Everett S. Lee of Schenectady, N. Y.; Director R. T. Henry of Buffalo, N. Y.; Director D. A. Quarles of New York, N. Y.; Vice-President-Elect Victor Siegfried of Worcester, Mass.; Vice-President D. G. Geiger of Toronto, Canada; Director E. P. Yerkes of Philadelphia, Pa.; Vice-President R. F. Danner of Oklahoma City, Okla.; Director Walter C. Smith of Palo Alto, Calif.

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

1 EAST 44TH STREET
NEW YORK 17

May 19, 1948

American Institute of Electrical Engineers,
33 West 39th Street, New York.

Dear Sirs:

We have examined the balance sheet of the American Institute of Electrical Engineers, and schedule of securities owned, as of April 30, 1948, and the related statements of cash receipts and disbursements of operating and restricted funds for the year ended that date. Our examination was made in accordance with generally accepted auditing standards and included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet, schedule of securities owned, and statements of cash receipts and disbursements, respectively, present fairly the financial condition of, and securities owned by, the Institute as of April 30, 1948, and its recorded cash receipts and cash disbursements for the year ended that date, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Yours truly,

(Signed) HASKINS & SELLS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Balance Sheet, April 30, 1948

Exhibit A

ASSETS		
Property Fund Assets:		
One-fourth interest in physical properties of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less depreciation and renewal reserve)	$342,957.02	
Funded depreciation and renewal reserve	155,491.46	
Total	$498,448.48	
Equipment:		
Library (volumes and fixtures)—estimated value	36,366.37	
Office furniture and fixtures (less reserve for depreciation, $30,708.19)	15,019.07	
Works of art, etc.	3,001.35	
Cash (no change during year)	612.91	
Total property fund assets		$ 553,448.18
Restricted Fund Assets:		
Securities—at cost, less reserve, $1,788.15 (quoted market value, $555,516.78)—Schedule 1	$534,223.30	
Cash (Exhibit *C*)	39,398.08	
Accrued interest receivable	125.40	
Total restricted fund assets		573,746.78
Operating Fund Assets:		
Cash (not including $2,031.98 for Federal taxes withheld from employees)—(Exhibit *B*)	$22,394.58	
Accounts receivable:		
Members—for dues (less reserve, $4,500.00)	11,824.95	
Advertisers	1,449.25	
Miscellaneous	4,356.05	
Accrued interest receivable	8,450.55	
Inventories:		
TRANSACTIONS, etc.	1,216.00	
"Electrical Definitions"	1,409.40	
Work in process (May issue of *ELECTRICAL ENGINEERING*, etc.)	14,271.27	
Text and cover paper	17,592.46	
Badges	7,123.35	
Total operating fund assets		90,087.86
Total		$1,217,282.82

LIABILITIES		
Property Fund Reserve		$ 553,448.18
Restricted Fund Reserves:		
Reserve capital fund	$544,847.61	
Life membership fund	8,636.75	
Member-for-Life fund	8,416.86	
International Electrical Congress of St. Louis library fund	6,400.11	
Lamme Medal fund	4,430.44	
Mailloux fund	1,015.01	
Total restricted fund reserves		573,746.78
Operating Fund Reserves, Liabilities, etc.:		
Accounts payable	$ 21,701.08	
Deferred income:		
Dues received in advance	3,390.00	
Entrance fees and dues advanced by applicants for membership	1,833.30	
Subscriptions to publications received in advance	18,998.34	
Miscellaneous (including unallocated receipts)	1,306.14	
Operating fund reserves	42,859.00	
Total operating fund reserves, liabilities, etc.		90,087.86
Total		$1,217,282.82

Statement of Cash Receipts and Disbursements of Operating Fund for the Year Ended April 30, 1948

Exhibit B

Cash on Deposit with The National City Bank of New York, May 1, 1947 (not including $1,664.75 for Federal taxes withheld from employees)			$ 6,883.37
Receipts:			
Dues (including $154,866.00 allocated to *ELECTRICAL ENGINEERING* subscriptions)		$332,459.02	
Advertising		128,817.86	
TRANSACTIONS subscriptions		10,651.82	
ELECTRICAL ENGINEERING subscriptions		31,941.83	
Miscellaneous publications (preprints, Standards, special reports, etc.)		41,976.23	
Students' fees		32,559.00	
Entrance fees		19,778.38	
Membership badges		4,913.15	
Transfer fees		3,448.75	
Interest and dividends on investments of Reserve Capital Fund		21,585.80	
Miscellaneous		33.38	
Total		$628,165.22	
Refund from Committee on Collective Bargaining and Related Matters		2,458.91	
Transfer from Reserve Capital Fund (see Exhibit *C*)		60,000.00	
Total receipts			690,624.13
Total			$697,507.50
Disbursements:			
Publications expense:			
ELECTRICAL ENGINEERING text	$172,956.32		
ELECTRICAL ENGINEERING advertising	71,069.15	$244,025.47	
TRANSACTIONS		5,387.45	
PROCEEDINGS		28,434.26	
"Year Book"		9,542.29	
Special publications		1,204.52	
Miscellaneous publications (preprints, Standards, etc.)		36,784.77	
Institute meetings		25,202.56	
Institute Sections		73,673.21	
Institute Branches		5,502.16	
Finance committee		750.00	
Headquarters committee		42.00	
Membership committee		16,311.43	
Standards committee		15,760.11	
Technical committees		11,442.38	
Committee on Institute publicity		900.00	
Planning and co-ordination committee		1,686.48	
Edison Medal committee		406.56	
Forward		$477,055.65	
Total (forward)			$697,507.50
Total (forward)			$697,507.50
Disbursements (forward)		$477,055.65	
Traveling expenses:			
Geographical Districts:			
Executive committees		7,959.71	
Vice-presidents		1,289.79	
Conferences on Student activities		14,177.09	
Board of directors		12,329.57	
Nominating committee		1,355.09	
President's appropriation		3,088.65	
AIEE representatives		192.17	
Administrative expenses		87,390.11	
Geographical Districts—Branch paper prizes		368.34	
Institute prizes—national		500.00	
Retirement system AIEE—normal contribution		7,319.58	
American Co-ordinating Committee on Corrosion		50.00	
American Standards Association		1,125.00	
Canadian Radio Technical Planning Board		10.00	
Canadian Council of Professional Engineers and Scientists		213.82	
Engineers' Council for Professional Development		1,812.50	
Engineering Foundation Project—Welding research		250.00	
Engineers Joint Council—General expenses		564.90	
Hoover Medal		291.72	
John Fritz Medal		110.00	
National Committee State Board Engineering Examiners		500.00	
National Fire Protection Association—Dues		60.00	
National Science Foundation		50.00	
Radio Technical Planning Board		400.00	
United Engineering Trustees, Inc.:			
Building assessments		18,825.18	
Library assessments		12,699.50	
Representation on labor panel and incidental expenses		4,501.83	
Lamme Medal expense (see Exhibit *C*)		109.30	
Membership badges		6,577.37	
Legal services		250.00	
Office furniture and fixtures and repairs		4,589.06	
Headquarters repairs, etc.		641.62	
Rent, etc., 500 Fifth Avenue		6,427.18	
Miscellaneous		61.19	
Total		$673,145.92	
Transfer to Member-for-Life fund		1,967.00	
Total disbursements			$675,112.92
Cash on Deposit with The National City Bank of New York, April 30, 1948 (not including $2,031.98 for Federal taxes withheld from employees)			$ 22,394.58

Statement of Cash Receipts and Disbursements of Restricted Funds for the Year Ended April 30, 1948

Exhibit C

		Restricted Funds					
	Total	Reserve Capital Fund	Member-for-Life Fund	Life Membership Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Mailloux Fund
Cash on Deposit With The National City Bank of New York and Various Savings Banks, May 1, 1947	$ 23,488.62	$ 10,976.67	$6,908.41	$3,532.39	$756.19	$160.00	$1,154.96
Receipts:							
Proceeds from sales, etc., of securities	$ 90,983.47	$ 90,983.47					
Income from bonds	422.84			$ 127.56	$135.28	$160.00	
Interest on bank balances	63.09			46.80			$ 16.29
Transfer from operating fund	1,967.00		$1,967.00				
Life membership fees	504.68			504.68			
Total receipts	$ 93,941.08	$ 90,983.47	$1,967.00	$ 679.04	$135.28	$160.00	$ 16.29
Total	$117,429.70	$101,960.14	$8,875.41	$4,211.43	$891.47	$320.00	$1,171.25
Disbursements:							
Purchase of securities	$ 16,471.08	$ 16,471.08					
Transfers to operating fund:							
To be repaid when adequate funds become available	60,000.00	60,000.00					
Other	775.75			$ 775.75			
Purchase of medal, cost of engraving, etc. (exclusive of $109.30 paid from operating fund)	170.00					$170.00	
Library purchases	156.24						$ 156.24
Traveling expenses	458.55		$ 458.55				
Total disbursements	$ 78,031.62	$ 76,471.08	$ 458.55	$ 775.75		$170.00	$ 156.24
Cash on Deposit With The National City Bank of New York and Various Savings Banks, April 30, 1948	$ 39,398.08	$ 25,489.06	$8,416.86	$3,435.68	$891.47	$150.00	$1,015.01

Schedule 1

Securities Owned, April 30, 1948

	Principal Amount of Bonds or Number of Shares of Stock	Restricted Funds: Reserve Capital Fund	Restricted Funds: Life Membership Fund	Restricted Funds: International Electrical Congress Library Fund	Restricted Funds: Lamme Medal Fund	Restricted Funds: Total
Railroad Bonds:						
Atlantic Coast Line First Consolidated 4%, due 1952	$ 4,000.00				$4,253.78	$ 4,253.78
Baltimore & Ohio, Pittsburgh, Lake Erie & West Virginia System 4%, due 1980	10,000.00	$ 6,450.00				6,450.00
Chicago & Erie Railroad Company 5% first mortgage, due 1982, registered	1,000.00	1,105.00				1,105.00
New York Central Railroad Company 4% series *A* consolidated mortgage, due 1998	15,000.00	9,812.50				9,812.50
Northern Pacific Railway Company 4½% collateral trust, due 1975	15,000.00	15,307.50				15,307.50
St. Louis–San Francisco Railway Company 4% series *A*, first mortgage, due 1997	1,200.00	1,200.00				1,200.00
St. Louis–San Francisco Railway Company 4% series *A*, first mortgage, scrip	198.00	198.00				198.00
St. Louis–San Francisco Railway Company 4½% series *A*, second mortgage, income bonds, due 2022	1,300.00	1,300.00				1,300.00
St. Louis–San Francisco Railway Company 4½% series *A*, second mortgage, income bonds, scrip	61.10	61.10				61.10
Total railroad bonds		$ 35,434.10			$4,253.78	$ 39,687.88
Public Utility Bonds:						
American Telephone & Telegraph Company 2¾% convertible debentures, due 1961	$25,000.00	$ 17,163.50	$5,153.12	$5,457.85		$ 27,774.47
United States Government Bonds:						
Treasury Savings bonds series *D*, due July 1, 1949	$10,000.00	$ 7,644.00				$ 7,644.00
Treasury Savings bonds series *D*, due January 1, 1950	10,000.00	7,500.00				7,500.00
Treasury bonds 2%, due March 15, 1952/50	25,000.00	25,617.19				25,617.19
Defense bonds series *F*, due June 1, 1953	34,000.00	25,160.00				25,160.00
Defense bonds series *G*, 2½%, due December 1, 1954	18,000.00	18,000.00				18,000.00
Treasury Savings bonds series *G*, 2½%, due September 1, 1955	40,000.00	40,000.00				40,000.00
Treasury Savings bonds series *G*, 2½%, due November 1, 1956	17,000.00	17,000.00				17,000.00
Treasury Savings bonds series *G*, 2½%, due May 1, 1957	20,000.00	20,000.00				20,000.00
Treasury Savings bonds series *G*, 2½%, due October 1, 1957	30,000.00	30,000.00				30,000.00
Total United States Government bonds		$190,921.19				$190,921.19
Capital Stocks:						
American Can Company	60 shares	$ 4,988.40				$ 4,988.40
American Telephone & Telegraph Company	100 shares	17,341.65				17,341.65
Atchison, Topeka & Santa Fe Railway Company preferred	200 shares	19,174.71				19,174.71
Boston Edison Company	200 shares	4,927.50				4,927.50
Commonwealth Edison Company	200 shares	7,580.68				7,580.68
Consolidated Natural Gas Company	100 shares	4,428.80				4,428.80
Dow Chemical Company $4 cumulative preferred, series A	100 shares	11,547.50				11,547.50
Eastman Kodak Company	(*a*) 300 shares	10,694.11				10,694.11
E. I. du Pont de Nemours & Company	80 shares	13,096.68				13,096.68
General Electric Company	200 shares	7,748.66				7,748.66
General Motors Corporation $5 preferred	200 shares	25,820.00				25,820.00
General Motors Corporation	100 shares	4,235.53				4,235.53
Gulf Oil Corporation	200 shares	12,264.20				12,264.20
Insurance Company of North America	100 shares	10,847.50				10,847.50
International Harvester Company	100 shares	5,030.50				5,030.50
International Match Realization Company, Ltd., voting trust certificates for capital shares of International Match Corporation	6 shares*	1,788.15*				1,788.15*
Louisville & Nashville Railroad Company	100 shares	6,278.13				6,278.13
Ohio Edison Company 4.40% preferred	200 shares	21,279.25				21,279.25
Pacific Gas and Electric Company	200 shares	8,420.99				8,420.99
Public Service Corporation of New Jersey 6% preferred	100 shares	11,150.00				11,150.00
St. Louis–San Francisco Railway Company voting trust certificates for 5% series *A* preferred stock	21 1800/10000ths shares	582.75				582.75
St. Louis–San Francisco Railway Company voting trust certificates for common stock	42 6000/10000ths shares	357.00				357.00
Scoville Manufacturing Company 3.65% cumulative preferred	100 shares	10,111.25				10,111.25
Sears, Roebuck and Co.	400 shares	6,014.97				6,014.97
Standard Oil Company of Indiana	200 shares	8,170.32				8,170.32
Standard Oil Company of New Jersey	200 shares	9,601.26				9,601.26
Union Carbide & Carbon Corporation	100 shares	7,277.42				7,277.42
United Fruit Company	300 shares	11,985.00				11,985.00
United States Steel Corporation 7% cumulative preferred	100 shares	14,885.00				14,885.00
Total capital stocks		$277,627.91				$277,627.91
Total		$521,146.70	$5,153.12	$5,457.85	$4,253.78	$536,011.45
Less reserve in full for securities considered to be of doubtful value		1,788.15				1,788.15
Total Securities, Less Reserve		$519,358.55	$5,153.12	$5,457.85	$4,253.78	$534,223.30

(*a*) Stock was split, effective May 15, 1947, by issuance of five shares for each share previously held.

OF CURRENT INTEREST

ESM Hears T. G. LeClair on Engineering Profession Unity

"Unifying the engineering profession is important—whether unification is accomplished through the avenue of the National Society of Professional Engineers, a national organization of local engineering societies, or a brand new organization, does not matter," explained AIEE Vice-President (District 5) T. G. LeClair (F '40) to 22 delegates of engineering organizations in Milwaukee, Wis., May 27. Mr. LeClair was invited to Milwaukee by the affiliate societies council of the Engineers' Society of Milwaukee to explain AIEE's studies on unification of the engineering profession.

Milwaukee, the host of the AIEE at its Midwest general meeting, October 18–22, 1948, is also the home of the Engineers' Society of Milwaukee, which is an example of the "society type" of local engineering organization. ESM just recently dedicated its new headquarters building. In 1948, the first meetings of the affiliate societies council were held, with which Milwaukee's engineers hope to supplement the professional work of the ESM. Each of nine local sections of national technical societies have equal representation on the council.

The prime purpose of engineers is to increase the productivity of tradesmen, and as a result, the engineering profession has specialized to the point where there are some 90 different engineering societies, explained Mr. LeClair. However, all engineers have certain desires in common, which are

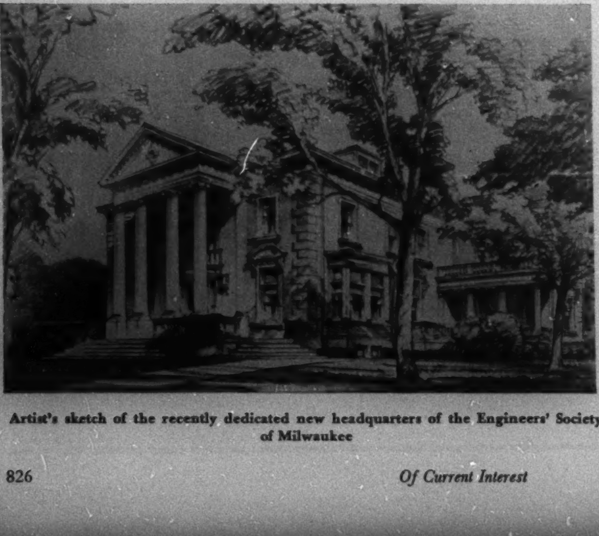
1. They want the same high caliber of young men to enter the profession.
2. They want a voice in the educational standards of engineers.
3. They want to raise the standard of competence of men engaged in the profession.
4. They want to see to it that the economic status of the engineer is commensurate with his contribution to society.
5. They want to protect the legal status of the profession, for example, by promoting sound licensing law.
6. They want to take part in community affairs and see to it that technical problems have sound solutions.
7. They want to have one organization that can speak for engineers on a national level.

Mr. LeClair explained how AIEE had set up a subcommittee to study the unification of the profession, and then had polled members to see what they thought was the best way to unify the profession. More AIEE members had favored the "American Society of Engineers" plan than any of the other plans. He explained that AIEE is proposing to some 25 technical societies that a constitutional convention of a national association be called.

The individual engineer can help the unification of the profession by taking the following steps, according to Mr. LeClair.

1. Register, to help establish a definite professional standard, and to encourage younger engineers to develop themselves professionally.
2. Join the National Society of Professional Engineers.
3. Form local organizations to work at the "grass roots" level, such as Milwaukee's ESM and its affiliate societies council.

At the Milwaukee meeting, representatives of the following organizations were present: AIEE, American Society of Mechanical Engineers, American Society of Heating and Ventilating Engineers, American Society of Civil Engineers, American Society of Refrigeration Engineers, Institute of Radio Engineers, and Society for the Advancement of Management. The Wisconsin Society of Professional Engineers, though not yet officially affiliated with ESM, also had a representative at the meeting.



Artist's sketch of the recently dedicated new headquarters of the Engineers' Society of Milwaukee

L. R. Grumman Awarded 1948 Daniel Guggenheim Medal

The 1948 Daniel Guggenheim Medal, given for notable achievements in the advancement of aeronautics has been awarded to Leroy Randle Grumman, chairman of the board of Grumman Aircraft Engineering Corporation, Beth Page, N. Y. The selection of the recipient for this highest American aeronautical honor is made by a board of 21 members consisting of the former recipients of the medal and representatives of the American Society of Me-

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Future Meetings of Other Societies

American Oil Chemist's Society. Fall meeting, November 15–17, 1948, Pennsylvania Hotel, New York, N. Y.

American Radio Relay League (ARRL) Convention. September 4–6, 1948, Milwaukee Auditorium, Milwaukee, Wis.

American Society of Civil Engineers. Fall meeting, October 13–15, 1948, Boston, Mass.

Association of Iron and Steel Engineers. Iron and Steel Exposition, September 28–October 1, 1948, Cleveland, Ohio.

Conference on Research Administration. September 13–15, 1948, Pennsylvania State College, State College, Pa.

First Annual All-Electrical Exposition. August 20–29 1948, Pan Pacific Auditorium, Los Angeles, Calif.

FM Association. Annual convention, October 11–12, 1948, Sheraton Hotel, Chicago, Ill.

Illuminating Engineering Society. National technical conference, September 20–24, 1948, Boston, Mass.

Institute of Radio Engineers. Pacific Coast convention, September 30–October 2, 1948, Los Angeles, Calif.

Instrument Society of America. Third instrument conference and exhibit, September 13–17, 1948, Philadelphia, Pa.

National Electrical Manufacturers Association. November 8–13, 1948, Atlantic City, N. J.

National Electronics Conference. November 4–6, 1948, Edgewater Beach Hotel, Chicago, Ill.

National Exposition of Power and Mechanical Engineering. November 29–December 4, 1948, Grand Central Palace, New York, N. Y.

National Plastic Exposition. September 27–October 2, 1948, Grand Central Palace, New York, N. Y.

National Research Council's Conference on Electrical Insulation. October 27–29, 1948, at the National Bureau of Standards, Washington, D. C.

National Television and Electrical Living Show. September 18–26, 1948, Chicago Coliseum, Chicago, Ill.

Porcelain Enamel Institute. Tenth annual forum, October 13–15, 1948, Urbana, Ill.

chanical Engineers, the Society of Automotive Engineers, the Institute of the Aeronautical Sciences, and United Engineering Trustees. The medal and a certificate were awarded for "outstanding achievement in successfully advancing aircraft design both for Naval and peacetime use."

Some of the other recipients of the Daniel Guggenheim Medal in the past include Orville Wright, Glenn L. Martin, Donald W. Douglas, Juan T. Trippe, Lawrence D. Bell, and T. P. Wright. Last year the medal was awarded to Major Lester D. Gardner.

Grumman is noted for the development of carrier-based aircraft, the *TBF* "Avenger," standard allied torpedo bomber from the time of the battle of Midway till "V-J Day," and the series of famous "Cats": *F4F* "Wildcat" which was featured in the early days of the war in the epics of Wake Island and Guadalcanal; the *F6F* "Hellcat"; the *F7F* "Tigercat," largest and deadliest carrier-based fighter ever produced; and finally the *F8F* "Bearcat," a propeller-driven airplane with a speed of 455 miles per hour. The company's amphibian private aircraft type is owned by many companies and private owners.

Mr. Grumman is a fellow of the Institute of the Aeronautical Sciences, member of the Society of Automotive Engineers, and rear commodore of the Manhasset Bay Yacht Club. He is a member of the Greater Cornell Committee and participated in the organization of the Cornell Aeronautical Laboratory.

CANONS OF ETHICS FOR ENGINEERS

FOREWORD

Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitute the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life. It is his duty to practice his profession according to these Canons of Ethics.

As the keystone of professional conduct is integrity, the engineer will discharge his duties with fidelity to the public, his employers, and clients, and with fairness and impartiality to all. It is his duty to interest himself in public welfare, and to be ready to apply his special knowledge for the benefit of mankind. He should uphold the honor and dignity of his profession and also avoid association with any enterprise of questionable character. In his dealings with fellow engineers he should be fair and tolerant.

PROFESSIONAL LIFE

Sec. 1. The engineer will co-operate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools, and the scientific and engineering press.

Sec. 2. He will not advertise his work or merit in a self-laudatory manner, and he will avoid all conduct or practice likely to discredit or do injury to the dignity and honor of his profession.

RELATIONS WITH THE PUBLIC

Sec. 3. The engineer will endeavor to extend public knowledge of engineering, and will discourage the spreading of untrue, unfair, and exaggerated statements regarding engineering.

Sec. 4. He will have due regard for the safety of life and health of the public and employees who may be affected by the work for which he is responsible.

Sec. 5. He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is serving as a witness before a court, commission, or other tribunal.

Sec. 6. He will not issue ex parte statements, criticisms, or arguments on matters connected with public policy which are inspired or paid for by private interests, unless he indicates on whose behalf he is making the statement.

Sec. 7. He will refrain from expressing publicly an opinion on an engineering subject unless he is informed as to the facts relating thereto.

RELATIONS WITH CLIENTS AND EMPLOYERS

Sec. 8. The engineer will act in professional matters for each client or employer as a faithful agent or trustee.

Sec. 9. He will act with fairness and justice between his client or employer and the contractor when dealing with contracts.

Sec. 10. He will make his status clear to his client or employer before undertaking an engagement if he may be called upon to decide on the use of inventions, apparatus, or any other thing in which he may have a financial interest.

Sec. 11. He will guard against conditions that are dangerous or threatening to life, limb, or property on work for which he is responsible, or if he is not responsible, will promptly call such conditions to the attention of those who are responsible.

Sec. 12. He will present clearly the consequences to be expected from deviations proposed if his engineering judgment is overruled by nontechnical authority in cases where he is responsible for the technical adequacy of engineering work.

Sec. 13. He will engage, or advise his client or employer to engage, and he will co-operate with, other experts and specialists whenever the client's or employer's interests are best served by such service.

Sec. 14. He will disclose no information concerning the business affairs or technical processes of clients or employers without their consent.

Sec. 15. He will not accept compensation, financial or otherwise, from more than one interested party for the same service, or for services pertaining to the same work, without the consent of all interested parties.

Sec. 16. He will not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with his client or employer in connection with work for which he is responsible.

Sec. 17. He will not be financially interested in the bids as or of a contractor on competitive work for which he is employed as an engineer unless he has the consent of his client or employer.

Sec. 18. He will promptly disclose to his client or employer any interest in a business which may compete with or affect the business of his client or employer. He will not allow an interest in any business to affect his decision regarding engineering work for which he is employed, or which he may be called upon to perform.

RELATIONS WITH ENGINEERS

Sec. 19. The engineer will endeavor to protect the engineering profession collectively and individually from misrepresentation and misunderstanding.

Sec. 20. He will take care that credit for engineering work is given to those to whom credit is properly due.

Sec. 21. He will uphold the principle of appropriate and adequate compensation for those engaged in engineering work, including those in subordinate capacities, as being in the public interest and maintaining the standards of the profession.

Sec. 22. He will endeavor to provide opportunity for the professional development and advancement of engineers in his employ.

Sec. 23. He will not directly or indirectly injure the professional reputation, prospects, or practice of another engineer. However, if he considers that an engineer is guilty of unethical, illegal, or unfair practice, he will present the information to the proper authority for action.

Sec. 24. He will exercise due restraint in criticizing another engineer's work in public, recognizing the fact that the engineering societies and the engineering press provide the proper forum for technical discussions and criticism.

Sec. 25. He will not try to supplant another engineer in a particular employment after becoming aware that definite steps have been taken toward the other's employment.

Sec. 26. He will not compete with another engineer on the basis of charges for work by underbidding, through reducing his normal fees after having been informed of the charges named by the other.

Sec. 27. He will not use the advantages of a salaried position to compete unfairly with another engineer.

Sec. 28. He will not become associated in responsibility for work with engineers who do not conform to ethical practices.

Prepared by Engineers' Council for Professional Development
29 West 39th Street, New York 18, N. Y.

A supply of the above "Canons of Ethics for Engineers" has been printed in size 9¹/₂ by 14 inches, suitable for framing, and copies are available from the offices of the Engineers Council for Professional Development, 25–33 West 39th Street, New York 18, N. Y. They are priced at 50 cents per copy, or, in quantities of ten or more, at 35 cents each

General W. H. Harrison Elected President of IT&T

Colonel Sosthenes Behn, chairman and president of International Telephone and Telegraph Corporation, New York, N. Y. has announced the election of Major General William H. Harrison (F '31) to the post of president as well as a director of the corporation.

Colonel Behn, who with his brother Hernand founded the company in 1920, will continue as chairman of the corporation and chief executive officer, thus again separating that office from the office of president, which he also has held since the death of his brother in 1933.

General Harrison, well known for his AIEE activities (*page 789*), will leave his present post of vice-president in charge of operations and engineering of the American Telephone and Telegraph Company to take up his new position which becomes effective September 1, 1948.

The appointment of General Harrison will allow Colonel Behn to devote more time to the many pressing international problems of the corporation and will leave him free to spend the necessary time abroad which these problems require.

Engineers and Scientists Needed by Navy Department

The Navy Department announces that it is seeking engineers and scientists in practically every field for employment in Washington, D. C. Specific vacancies exist for aeronautical, civil, electrical, electronics, industrial, marine, and mechanical engineers, and for mathematicians, naval architects, physicists, and others, with salaries ranging from $2974.80 to $10,330.

Some of the positions involve occasional travel to naval shore establishments for the purpose of observing or participating in scientific tests of naval equipment. Others require original research, or planning of scientific programs. All of the positions are concerned with the most recent advancements in the scientific field.

Applications for the positions should be made on standard form 57, available at any first or second-class post office, and should be mailed to Code 612, Room 1213, Main Navy Building, 17th and Constitution Avenue, Washington, D. C.

Harvard Professors Issue Applied Science Monographs

The "Harvard Monographs in Applied Science," a new series of brief, high-level treatments of advanced scientific subjects by Harvard faculty members in the departments of the physical sciences and of engineering, will be published jointly by the Harvard University Press and John Wiley and Sons beginning next year.

The series has been planned to include monographs on such subjects as ultrasonic generators, the theory of the magnetron, earth waves, meteors and the upper atmosphere, applications of seismology to engineering, and high-power vacuum tubes. The first volume, scheduled for early in 1949, will be P. E. LeCorbeiller's "Modern Network Theory." It is expected that six or eight additional monographs will be published during the two or three years following, with a considerably larger number anticipated over a longer period.

The project is under the supervision of an editorial committee headed by Frederick V. Hunt, chairman of the department of engineering sciences and applied physics, and Professors Hunt, H. W. Emmons, and L. D. Leet each will contribute a monograph in the series. Other Harvard faculty members whose monographs will be published within the next two or three years are E. L. Chaffee, Frederick L. Whipple, and Leon N. Brillouin.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Electrical Essays

To the Editor:

This letter is in answer to the "Electrical Essay" appearing in the February issue (*EE, Feb '48, p 187*). The point raised by Doctor Slepian is a very interesting, and, I believe, very basic one. Of course the God is right, at least in a sense. The matter of whether or not there are magnetic charges would appear at first sight to be an important one, but upon closer examination it appears to be mainly a matter of definition. As Doctor Slepian points out no experiment would reveal the answer. Since this is true, the question of the existence of such charges is of a purely academic nature.

However, even from this point of view, it is possible to justify the field equations as they stand. Following the work of Leigh Page in his "Electrodynamics," we may set up the field equations under the hypothesis that magnetic charges do, in fact, exist. These equations are

$$\text{div } \mathbf{E} = p_E \qquad \text{div } \mathbf{H} = ap_E$$

$$\text{curl } \mathbf{B} = -\frac{1}{c}(\dot{\mathbf{H}} + apV) \qquad \text{curl } \mathbf{H} = \frac{1}{c}(\dot{\mathbf{E}} + pV)$$

$$\mathbf{F} = p_E(\mathbf{E} + a\mathbf{H}) + \frac{1}{c}p_E V \times (\mathbf{H} - a\mathbf{E})$$

If we then write these equations in terms of two new field quantities defined as

$$\mathbf{A} = \frac{\mathbf{E} + a\mathbf{H}}{\sqrt{1+a^2}} \qquad \mathbf{B} = \frac{\mathbf{H} - a\mathbf{E}}{\sqrt{1+a^2}}$$

$$p = \sqrt{p_E^2 + p_H^2} = p\sqrt{1+a^2}$$

Then in terms of A and B, the field equations become

$$\text{div } \mathbf{A} = p \qquad \text{div } \mathbf{B} = 0$$

$$\text{curl } \mathbf{A} = -\frac{1}{c}\,\mathbf{B} \qquad \text{curl } \mathbf{B} = \frac{1}{c}(\dot{A} + pV)$$

$$\mathbf{F} = p\left(A + \frac{1}{c}V \times \mathbf{B}\right)$$

These last equations are exactly equivalent to Maxwell's equations and we can see that the form of the equations and the form of the field vectors are mutually arbitrary. Or stated more succinctly, the field equations actually define the field vectors in a self-consistent way.

This should not be too startling as the same factors appear in a critical study of Newton's Laws. That is, the so-called laws are in themselves just sufficient to define in a consistent and convenient way the two quantities they introduce, namely force and mass.

By the way, I recommend highly Page's "Electrodynamics" to anyone interested in the foundations of electromagnetic theory.

JAMES MORAN (M '45)
(Graduate student, Case Institute of Technology,
Cleveland, Ohio)

To the Editor:

The electrical essay by Doctor Slepian in *ELECTRICAL ENGINEERING*, April 1948, (*EE, Apr '48, p 337*), regarding the two batteries emphasizes an important difference of viewpoints, and an unhealthy situation in electrical theory. Following Poynting's enunciation of his theorem in 1884, many scientists of note became proponents of the idea that the energy associated with the flow of current in a conductor resides in the medium surrounding the conductor. This idea has much support today, especially in the circles mentioned in the essay. On the other hand the power engineer feels instinctively that there is much going on in the conductor that the Poynting theorem does not take into account. He knows that if the entire system were shielded and biased so that the external fields were nullified, the flow of energy from source to load still would continue as before in a simple circuit such as that of the essay. For an interesting account and searching analysis of the Poynting theorem see O'Rahilly.[1]

The power engineer is handicapped in the support of his beliefs because most of the mathematical physicists have been on the other side, and therefore the theory of simple conduction has been neglected. To be sure, the mechanics of the process has been subjected to study, and we have a fairly good idea of what goes on in the conductor. See, for instance, Houston.[2] But little has been done about what causes the process to take place. The following remarks are intended to assist in that regard.

A source of potential produces a displacement of electric charge. This may be accomplished in a number of ways, such as: magnetically in the dynamo; by atomic excitation (unbalance) in the photoelectric cell; propinquity of different substances as in the thermocouple and other contact (or boundary) devices; and by ionic dissociation and polarization as in the battery. In all these cases the naturally uniform distribution of charge is caused or permitted to become unbalanced. As the negative charge is the more mobile, we can say that the general result is an accumulation of negative charge on one terminal of the device and a rarefaction of negative charge on the other terminal. This proceeds until the forces of unbalance equal the internal generative forces.

So long as there is no external circuit connected across the poles, and disregarding local action and leakage, this displacement of charge is maintained in status quo by the internal forces. However, when an external circuit exists, the displacement can extend beyond the terminals. Having done so to some extent, there exists a condensation of negative charge in that portion of the circuit near the negative terminal and a rarefaction near the positive terminal. These conditions proceed to extend along the circuit, establishing what we call a flow of current. If the source is a d-c source, a uniformly varying density will become established along each portion of the circuit having uniform characteristics, and we say a steady state exists.

These matters were touched upon briefly by the writer in a previous communication[3] which was directed primarily toward a somewhat different subject. However, as stated there, the forces of electrostatics are of tremendous magnitude as compared with the common magnetic forces. It readily can be appreciated, therefore, that a very slight condensation or rarefaction of charge is sufficient to maintain a substantial flow of current. It need cause no concern that this concept requires a nonuniform density of charge along the circuit (contrary to the commonly accepted idea that conduction proceeds with electrostatically neutral conductors) because we know that there is a voltage drop along the circuit. This voltage drop means a difference of potential, and difference of potential is only another way of saying difference of density of charge. Thus current flow is seen to be analogous to hydraulic flow, with an extremely incompressible fluid of exceedingly minute mass. It should be clear that this same analysis applies equally well to alternating currents and transient phenomena, although in these cases there are certain other effects which are not pertinent to the present communication.

It therefore appears that in the essay each battery governs the activities in its own circuit and load, and the power engineer is right. It might be well to point out at this juncture that the ideas of the radio engineer are derived from findings and opinions developed at a time when the understanding of current flow and space phenomena just was emerging from its obscure beginnings, and the entire concept should be given a thorough overhauling. The Poynting vector is only an indicator, a straw in the wind which shows the direction in which the breeze is blowing if all the factors are employed correctly. Like any indicator, it should be used with caution in the role of a determinant.

REFERENCES

1. Electromagnetics (book), **A. O'Rahilly.** Longmans, Green and Company, New York, N. Y., 1938. Page 275.

2. The Theory of Electrical Conductivity, Recent Developments, **W. V. Houston.** AIEE *TRANSACTIONS*, volume 49, January 1930, page 30.

3. An Analysis of Electromagnetic Forces, **W. A. Tripp.** *ELECTRICAL ENGINEERING*, volume 64, October 1945, page 351.

WILLIAM A. TRIPP (M '35)
(Electrical engineer, Ebasco Services Inc., New York 6, N. Y.)

To the Editor:

The interesting electrical essay on page 337 of the April 1948 issue of *ELECTRICAL ENGINEERING* catches my eye. I entirely side with the power engineer as I suspect all radio engineers of witchcraft (pure ignorance, no doubt!), and suggest the following "common sense" attack:

Take the diagram exactly as shown, that is, d-c sources and pure resistance loads; then the loads can be detected by the heat generated in them. No one will deny that removal of source *X*2 from the circuit will cease to keep load *R*1 hot; also removal of source *X*1 will not affect the heating of *R*1.

My view is, therefore, that when both loads and sources are connected, measurements cannot distinguish between which feeds which as sources and loads are identical and interchangeable. But by physical interference such as I have suggested, it is proved that *X*1 feeds *R*2, and *X*2, *R*1.

I enjoy this feature very much. More, please!

FRANK WOODWARD ROBERTS (M '45)
(Ashdown, Western Road, Billericay, Essex, England)

To the Editor:

I have heard from a number of AIEE members protesting my answer in *ELECTRICAL ENGINEERING*, January 1948, page 58, to my quiz problem published as an "Electrical Essay," in *ELECTRICAL ENGINEERING*, September 1947. In my answer I gave a simple example showing an electrostatic line of force making an angle not 90 degrees with the smooth surface of a perfect conductor.

In particular, W. H. Gamble, K. W. Miller, and W. Richter maintain that at the point *A* at the surface of the conductor in my figure, the electric field intensity *E* is zero and, therefore, has no determinate direction there. Therefore, say Messrs. Miller and Richter, the line of force at *A* can have no direction there. Professor Gamble goes farther, and says that there is no line of force which reaches *A*.

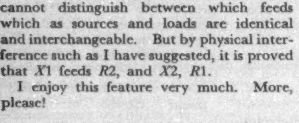

Figure 1

I believe these remarks indicate a confusion between the notion of a line of force, and the electric force or electric intensity itself. They imply that my statement that a line of force makes an angle of 45 degrees with a conducting surface at one of its points, is entirely equivalent to the statement that the electric force or field intensity also makes an angle of 45 degrees with the surface there. This is not at all the case.

Although it is defined by means of the electric force, the line of force itself is not a vector, but a geometric curve. Like any other geometric curve, it has direction, but its direction is determined at a point by the disposition of the *other points on the curve* which lie in the neighborhood of the given point. If only a single point of a curve is given, then it is not possible to determine its direction. We must know also the positions of neighboring points.

Figure 1 of this letter shows the various lines of force in the vicinity of the point *A* in question on the conducting surface. All along its length the line of force *PA* in question has its neighboring points so disposed that the direction they determine is 45 degrees from the normal to the surface. This is true, no matter how closely we approach the point *A* on the curve. As the curve approaches *A*, there is no wobble or wavering. The neighboring points of *A*, on *PA*, continue to determine a direction at 45 degrees to the normal.

It is true that all the *other* nearby lines of force either meet the surface at right angles or fail to meet the surface. However, the direction which *PA* has, is its own business and is a property of the disposition of its own points, and not of those of the neighboring other curves. And *PA* insists on keeping itself at 45 degrees to the surface.

If Messrs. Gamble, Miller, and Richter were asked to draw a line at *A* at 45 degrees to the surface, would they draw a curve which would differ in any way from the line of force *PA*?

On the other hand, the electric force or field intensity is a vector, defined, in principle at least, at any individual point in free space without reference to its values at neighboring points. It is the force (mechanical or otherwise) per unit charge, required to hold a very small charge at rest at the point under consideration. Unlike the direction of a curve, we may speak of, and in principle observe or measure, the electric force at an isolated point. Being a vector, the electric force has a direction, unless its magnitude is zero, in which case it has no direction.

Professor Gamble raises the question whether the point *A* should be regarded as being on the line of force *PA* or not. Apparently, he would prefer that the line of force have no end, than have it *meet* the surface at 45 degrees. This question is somewhat delicate. As its answer depends on the definitions we adopt for quantities at the conductor surface, it is largely a matter of taste.

For example, what is the electric force at a point of the conductor surface? We cannot use the definition for free space given in the foregoing, for how can we determine the force (mechancial or otherwise) needed to hold a small enough charge at rest there? The charge at the surface itself is apparently in equilibrium, so the net force per unit charge for it is zero there. Shall we therefore make the electric force zero there? On the other hand, we correctly may calculate the forces (mechanical or otherwise) required to keep the conductor itself at rest if we ascribe to each unit area a normal force equal to $\sigma^2/8\pi$ where σ is the charge density. This would make the electric force or electric intensity at the surface, normal, and equal in magnitude to $E=\sigma/8\pi$. On the other hand just outside the surface the electric force is normal, but equal in magnitude to $E=\sigma/4\pi$.

Evidently, although frequently not explicitly stated, we arbitrarily define the field at a point of the surface of the conductor as equal to that just outside the conductor there, or more exactly as the limit which the electric field at a point outside the conductor approaches as that point approaches the given point of the conductor surface.

As we pass through the conductor surface, in general there is necessarily a discontinuity. Just outside the surface, the electric field is generally not zero. Inside the surface, by definition of a conductor, the electrostatic field is always zero. Just outside the surface, lines of force generally are approaching the surface normally. Inside the surface, there are no lines of force.

What we do at the surface itself is a matter of definition or taste. We may match all the quantities at the surface on to the quantities outside, thus throwing the discontinuity on the inner side of the surface. We may match equally well, however, the quantities at the surface on to the quantities inside, or, if we please, we may give the surface quantities values intermediate between those inside or outside.

It is customary to adopt the first of these alternatives. The electric field at the surface generally is taken to have the magnitude $E=\sigma/4\pi$, matching on to the points outside. Points at the surface are said to lie on lines of force, even though points just inside the surface do not lie on lines of force.

Apparently, Professor Gamble follows the usual convention, generally, since at points other than *A* he is quite willing to have a line of force *meet* the surface. That is, he makes a surface point such as *B* match on to the *exterior* of the surface. However, the point *A*, he prefers to match on to the inside of the surface, and lie on no line of force.

There is no purely logical objection to Professor Gamble's choice. It is merely a matter of taste. With his choice, I grant that the line of force *PA* does not *meet* the conducting surface. However, I am rather sure that he will say that it makes an angle of 45 degrees with the surface there, even if according to his choice it does not meet it there.

J. SLEPIAN (F '27)
(Associate director, research laboratories, Westinghouse Electric Corporation, East Pittsburgh, Pa.)

To the Editor:

In his letter Doctor Slepian states: "I believe these remarks (made by Messrs. Gamble, Miller, and Richter) indicate the confusion between the notion of a line of force, and the electric force or electric intensity itself." After reading the rest of Doctor Slepian's letter, I also believe that the argument has arisen because of the confusion in regard to the definition of line of force and the confusion apparently carries back to the original statement of the essay.

In his argument, Doctor Slepian says his line of force is defined by the electric force but does not tell in what manner it is so defined. In Eshbach, 8–35, "A line drawn in an electrical field in such a manner that its direction at each point coincides with the direction of the field at that point is called a line of electric force." In Timbie and Bush, page 283, "A flow line is defined such that the electric field intensity at any point on the line is tangent to the line." In other textbooks, I find essentially the same definition. These definitions, of course, will not allow the line of force to have two directions, differing by 90 degrees at one point such as Doctor Slepian has drawn in his diagram. If the solution to the essay was to be based on a personal or unusual definition of the line of force, that should be so stated in the original statement.

Later in his letter Doctor Slepian says, "Apparently he (Professor Gamble) would prefer that the line of force have no end, than have it meet the surface at 45 degrees." I would point out that the conclusion, that a line of force approaching point A necessarily must pass through point A or have no end, is Doctor Slepian's conclusion and not mine. I have no difficulty picturing the line of force changing direction before it gets to point A and either meeting the surface at 90 degrees at some point near A, or missing the surface entirely when continuing on to the negatively charged cylinder.

If Doctor Slepian feels that some line or lines of force must be drawn at a point of zero field intensity such as point A, then the picture as drawn by Mr. Miller of two lines, each meeting the surface at 90 degrees at point A, is much more acceptable to me. Just what is the implication of such a diagram at point A I suppose is also open to argument. But such a diagram does have the advantage of being in agreement with the common definition of the line of force, and the statement that all lines of force are at right angles to unipotential surfaces.

W. H. GAMBLE (M '33)

(Head, electrical engineering department, South Dakota State College of Agriculture and Mechanic Arts, Brookings, S. Dak.)

To the Editor:

. . . Whatever may be the merits of the various answers given to the problem, I do not believe that the problem deserves as much argument as it already has received. It appears to me that the answer to it will depend altogether too much on certain definitions—and it seems to me that everyone may write his own definitions if he so chooses—and furthermore the problem has too many pitfalls of the nature, "When you decrease a circle, when does it cease to be a circle and become a point?"

Nobody ever has seen a line of force, but they are being drawn daily in accordance with the mental definition of the man who draws them. I believe we are all in agreement when we state that an electrostatic field is a vector field, and I feel that we all have a pretty definite picture about what is meant by this statement. At every point of the region in question the electric field intensity, defined as the force acting on the unit charge, has a certain magnitude as well as a certain direction. No "neighboring point" is needed in this definition. "Line of force" on the other hand is a very vague term and although everybody seems to know what is meant by it, I would not want to have the job of writing a definition immune to attack. There are various things pertaining to lines of force which I remember from school and which so far have served me well. The direction of the line of force is supposed to be everywhere the same as the vector of the magnetic intensity. If this were all that counts, I believe I could agree with Doctor Slepian, because under this definition it might be permissible to extend a line beyond a given point to the neighboring point even if there should be no force at the neighboring point any more.

But I remember two more things, or perhaps just one, because the two seem to proclaim the same thing: the density of the lines per square inch or per square centimeter is supposed to be a measure for the field strength. Furthermore, every electrostatic line is supposed to start and finish on a charge, that is, 4π lines emanate from, or terminate on, the unit of charge. In the configuration shown in Doctor Slepian's example the induced charges on the flat plate change their sign as we go from left to right through point A. The density of electric charge at point A therefore must be zero. As far as I am concerned, both of these statements lead me to the conclusion that no line of force can terminate at point A. I am not arguing about the fact that the line PA approaches point A under 45 degrees (although I do not see at the moment why it could not be 30 degrees or 60 degrees) but I refuse to be inveigled into stating what happens at point A itself. The density of the electric field lines at point A is supposed to be zero, so it is rather difficult for me to talk about the direction of lines at a point when their density is zero.

Now, if Doctor Slepian chooses to define the line of force as a geometric curve, a different result can be expected. Perhaps his is the right definition, but as far as I am concerned, I am going to stick with the old type of definition, which in turn means that for me there is nothing to talk about at point A.

Until we have an exact and accurate definition of what is meant by "line of force" I feel that the arguments about the correctness of the various solutions to Doctor Slepian's problem are rather futile.

WALTHER RICHTER (F '42)

(Consulting electrical engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.)

To the Editor:

With considerable impish glee several years ago I read the fable of the wine merchant and his mathematician and the profound difficulties they encountered with tensors in the liquor business. I recognize the creator of this myth as a man of rare wit and good humor and one with ability of which to beware in any public controversy. Has he now brought out a battering ram to swat a fly or, tongue in cheek, is he pulling somebody's leg?

I cannot speak for Messrs. Gamble or Richter but (being contrary by nature myself) I do not choose to draw one 45-degree line at A. Instead I note the symmetry of the curves at B with their counterpart to the left of A. I also note that as they approach A they become straighter with an increasingly sharp hook at the end. Therefore at A I draw two curves which start out in coincidence, both perpendicular to the surface at A, but which have zero radius of curvature for zero arc length, that is an infinitesimal cusp at A joining the two 45-degree lines of prolongation, one of which, $A-P$, Doctor Slepian assumes I must draw everywhere straight.

I would justify this procedure on the grounds that we have a 2-dimensional configuration, and the point A can be approached as logically along the (surface) line $B-A$ as along any other path. Equally convincingly I could proceed down a vertical path to A and, in the limit, show that the critical line $P-A$ is only half of a V-shaped curve which is two straight lines joined by an infinitesimal arc of infinite curvature tangent to the conductor surface at A.

Thus we have at least three discordant results, one of Doctor Slepian's and two of mine depending on how we approach the problem. However at this point of the discussion I lose interest as, in actuality, the "perfect conductor" at best must have a surface roughness and discreteness imposed by electronic and atomic granularity which is much coarser than the mathematical "points." How lines of force or electrostatic flux meet the surface (or bury themselves in the volumetric charge) of the electron or proton is as yet, I believe, an unsettled, perhaps meaningless, question.

Should we criticize with tolerant amusement the medieval theologians for arguing about how many angels can dance on the point of a needle or would that be unjustly "needling" them? Shades of Bishop Berkeley!

K. W. MILLER (M '29)

(Assistant director, Armour Research Foundation, Chicago, Ill.)

Oil Supplies

To the Editor:

I was very much interested in the article entitled "America's Future Power Needs," by F. R. Benedict in the May issue (*EE, May '48, pp 477–82*). Under the heading "Petroleum" he stated, "America's oil shortage is acute and is expected to get worse before it improves." This statement is debatable. In the March 19, 1948, issue of the *Lamp*, publication of the Standard Oil Company of New Jersey, I quote, "The outlook for the heating season of 1948–1949, although it may be tight, the situation looks better than it did last fall. Next fall, the industry is expected to have both larger stocks and improved transportation facilities. Thus, production plus the usual seasonal draft on stocks, should enable the industry to meet requirements substantially higher than the 218 million barrels of distillates and 74 million barrels of kerosene which it supplied during the winter just ended."

I have read in many magazines and

publications that the United States will import about 175 million barrels of crude and refined products. From sources which I feel to be reliable, I have been told that all indications show there will be eight to ten per cent more fuel oil available this coming winter than last.

Further on in Mr. Benedict's article he states, "The oil burner industry is manufacturing units at a rate of more than two million a year and if the expected conversion rate is attained, this will increase from 3 to 3¹/₂ million units a year." He also calls attention to the dwindling oil reserve. Again quoting the *Lamp*, "Right now the country's reserve of recoverable oil in developed fields, known to oil men as reserve, is the highest in history." *Fuel Oil Heat and Oil Heat* magazine, in a recent issue, stated that it was estimated that slightly more than 800 thousand oil burners were installed in the United States and not more than a million were manufactured. As far as the oil burner industry is concerned, they estimate that on January 1, 1948, there were 3,585,931 oil burners in use in the United States. There is plenty of oil in the United States yet to be discovered. At least 50 billion barrels in land areas alone, with several additional billion barrels conservatively estimated for off-shore areas lying under less than 100 feet of water. The Bureau of Mines recently estimated that 1948 United States domestic demand for oil heating will be 7.3 per cent higher than in 1947. An estimated decline in exports of 15.1 per cent, however, will result in a total over-all increase in demand in 1948 of 5.6 per cent. With an increase in supply of approximately 8 per cent, this increase in demand should be met satisfactorily.

I want to take this means of complimenting Mr. Benedict on his statement, "Because of the cleanliness and because it can be controlled automatically, the oil burner will find high favor for home and industrial use." After 24 years in this industry, I feel that the strides we have made in the development of efficient oil burners shortly will make itself felt.

ALFRED A. ABRAHAMS (A '47)

(Vice-president, Federal Oil Burner Company, Inc.,
Philadelphia, Pa.)

Flow Meter

To the Editor:

This is in reply to J. H. Laub's letter to the editor in the May issue (*EE, May '48, p 511*).

In his article, "An Electric Flow Meter," which was published in December (*EE, Dec '47, pp 1216–19*), Doctor Laub claims, after mentioning a number of mechanical flow meters, that he has invented a "new instrument," the electrocaloric flow meter. In a recent letter to the editor (*EE, Mar '48, p 311*) I showed that this principle was published in 1911 and that electrocaloric flow meters have been in production, both in the United States and abroad, for more than 20 years.

Neither the use of a by-pass (to reduce the amount of electric energy needed for heating), nor the application of indirect heating in place of direct heating, nor the application of the principle to a liquid are sufficient to call the Laub meter" a new instrument," without giving any reference to the old Thomas meter.

The Laub meter is only a reissue of the Thomas meter of 1911, built with the electronic tools of 1947.

GEORGE KEINATH (M '37)

(36 Knollwood Drive, Larn Larchmont, N. Y.)

Graduate Study

To the Editors:

Professor Hansteen's letter in the March issue (*EE, Mar '48, p 311*) raises some interesting points for discussion, and indicates what may be a divergent trend of thought on what should constitute a standard curricula for engineering education.

It would seem that many educators agree with Professor's Sorensen (*EE, Nov '47, pp 1049–53*) and Hansteen in the advocation of a larger proportion of physical science education for both undergraduate and graduate students.

I am of the opinion that educators in general tend to disregard the practical aspect of the functions of the engineering school of the present day, that is to provide engineers to serve industry and the lay public at large. This brings up the question "What does industry require of an engineer."

Considering the broad pragmatic concept of engineering, this question is difficult to answer; however, it is possible that for 50 per cent of all engineering practice the requirements are

1. A thorough knowledge of the mechanics, standards, and practices, together with a good knowledge of fundamentals and how to apply them.
2. An extensive knowledge of higher physics desirable but not entirely necessary.

Thus we find industry in general setting up two standards for engineering training, one for the average engineer, requiring the usual 4-year engineering course, and another, the standard for research and development requiring postgraduate study up to the doctorate level.

From the educator's viewpoint the substitution of more education in the physical sciences in lieu of the purely technical subjects which at present form a large part of undergraduate education is considered a necessary improvement.

This is indeed a worthy aim and I am fully in accord with Professor Hansteen granted that we still are able to provide the knowledge of techniques which industry requires.

In my opinion this brings into sharp focus the necessity of pre-engineering school training for those items in engineering which can be considered either manual training or specialized technical training.

To serve this need will require the adoption of pre-engineering training in the junior and senior high school years, and as this involves a considerable measure of co-operation from local school committees, and possibly additional expense for the taxpayer, it is a matter of conjecture as to the possibility of formulating and progressing such a program.

Possibly engineering colleges could set up their own pre-engineering school with a suggested 2-year course.

Credits for entrance could be granted after the completion of the sophomore year in high school with a view to screening prospective students. With this educational scheme the undergraduate student would be better prepared to take more advanced study in physical sciences as advocated by Professor Hansteen, and still have the knowledge of mechanical skills that industry requires of a trained engineer. An alternative scheme, one which I believe would be easy to organize is to divide each engineering course into two separate and parallel sections—one section to be the professional or industrial course leading to a degree designated as bachelor in engineering, the other section to be the scientific course leading to bachelor of science.

The curricula for the professional course would be somewhat similar to existing curricula, modified to meet the needs of modern industrial practice. The scientific course would not include any practical or technical training such as surveying, shop practice, routine testing, or instrumentation, and would include work in applied research. I believe that this educational scheme would not involve major changes in teaching staffs, or present any difficulty in arranging class time tables.

After reading various articles and letters to editors of scientific and engineering journals I reluctantly have arrived at the conclusion that, although there has been a considerable amount of discussion, and also a revision of postgraduate courses leading to a doctorate degree in a few institutions of learning, a definite or systematically thought out program which could be adopted by any engineering collecte has not been suggested as yet.

Many noted educators recently have advocated a 5-year course for the bachelor of science degree. Does not this recognize a weak link in our educational system somewhere?

To enlarge and lift up the professional standing of engineering is a laudable ambition, and requires the hearty support of all engineers, but I question whether additional years of academic training is entirely adequate.

Considering the intangible factors which are part of the characteristics of a good engineer, such as initiative, judgment, and general personality, qualities which are rounded out by experience, does it not seem that before lengthening the period of study an investigation should be made as how the students' time could be utilized more efficiently?

As Professor Hansteen remarks in his letter, this means the elimination of out-moded curricula. A house is no better than its foundation, and I am of the opinion that the satisfactory solution to this important question is either the adoption of pre-engineering college training and/or of subsequent revision of curricula.

With this good foundation the higher academic courses easily could be revised accordingly as the entrant students would be more adequately equipped, and considering that in future years research will demand a larger proportion of research engineers than heretofore, it would seem to be necessary to prepare those engineers whose bent is toward higher academic study or research. This does not necessarily mean the relegation of the engineer in industry to a secondary role since his training and experience is in a field of engineering with which the research engineer is not expected to be too familiar.

Professor Sorensen stated in his article that scientists had been able during the war years to accomplish considerable work in purely engineering projects efficiently.

I personally do not entirely agree with this statement as my experience with radar and degaussing scientists during the recent war showed the necessity to have a competent engineer effect the completed design after preliminary calculation and layout was initiated.

This is not in any way considered a reflection on the capabilities of the scientists, but does indicate a divergent training and experience.

Summing up my remarks I believe a rational approach to the improvement of engineering curricula should include the viewpoints of leading engineers in industry, and private consulting engineers, together with those of scientists and educators.

There definitely would have to be some compromise but I believe that a sound and practical program could be set up as a guide, with the primary thought in mind that the engineering profession should serve the lay public at large.

VERNON UTTLEY (M '47)
(Chief, Projects Branch, United States Army Forces Antilles, Office of the Antilles Engineer, APO 851, c/o Postmaster, Miami, Fla.)

Voltage Notation Conventions

To the Editor:

In the article "Voltage Notation Conventions," by M. B. Reed and W. A. Lewis (*EE, Jan '48, 41–8*) the authors reach the conclusion that the system, concepts, and methods, coming under the classification of their convention IIA is preferable to any other. I would like to add my vote in hearty support of this conclusion.

There are two reasons in particular for supporting this conclusion. First, by throwing out voltage rises as a separate entity from voltage drops, the problem is simplified in what I think is a greater ratio than the 2-to-1 ratio between the number of types of voltages considered. Saying this another way, if voltages in a vector diagram consist of voltage rises and voltage drops in the same diagram, the problem is more than twice as hard to understand, teach, or discuss than it is with only voltage drops. Secondly, I believe that far more vector diagrams are drawn for energy consuming devices, or loads, where voltage drops are more appropriate, than there are for generators.

In further development of my first point, I would like to recite my experience in endeavoring to teach the subject of vectors for a number of years in two separate graduate level courses offered in the New York area. At first, I thought that the best rendition of the subject was to cover all three of the basic conventions mentioned in this article. The reasoning back of this was the thought that my students would be discussing their vector diagrams with other persons who might be using any one of the three conventions, and, therefore, if my students were thoroughly conversant with all three conventions, less time would be lost in argument. This was a mistake. My students had been out of college anywhere from 1 to 25 years or more, and a multiplicity of points of view all at the same time in the same diagram was something they definitely did not care for. "Give us what you think is the best system," they said, "and let it go at that." After that, I found it much easier to explain that any voltage could be considered as a voltage drop and the vector drawn accordingly, regardless of the adjective used in connection with that voltage, such as induced, generated, counter, impedance, and so forth.

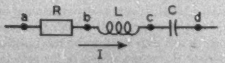

Figure 1

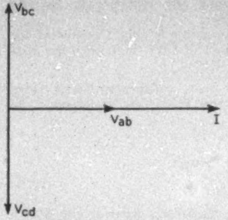

Figure 2

My second point perhaps would require statistics to prove. Nevertheless, I found that when I drew two simple reference diagrams based on load consuming devices at the very start of the discussion, the teaching problem proceeded on a much more even keel. These are shown in Figures 1 and 2 of this letter. Figure 1 is the connection diagram showing a simple series circuit consisting of a noninductive resistor, a pure inductive reactance, and a pure capacitive reactance. Figure 2 is the vector diagram for Figure 1, which shows a reference current vector, a resistance voltage drop in phase with the current, an inductive reactance voltage drop 90 degrees leading the current, and a capacitive voltage drop 90 degrees lagging the current vector. The point letters on the connection diagram, and the double subscripts on the vector diagram are in agreement with convention IIA. I believe that the inclusion of two such diagrams in the possible revision of the standards along the lines of convention IIA would be greatly beneficial.

In connection with Figure 6 and of the article and the authors' discussion of it, I am glad to observe that they do not advocate as a standard the placement of individual letters at the ends of vectors. There is, admittedly, some advantage now and then in doing this for a person who can do it and not be confused. On the other hand, I feel that this single aspect of possible vector systems has led to far more confusion and argument than the slight occasional advantage warrants. Further, I do not believe the practice is warranted by the present definition of a vector. As we interpret the definition in electrical engineering, a vector quantity is a sinusoidally varying electrical quantity having magnitude and a time phase relationship to other similar quantities or a reference axis. Thus, in a vector diagram, the magnitude is depicted by the length of the vector, and the angle with respect to the X-axis gives us the time phase. That is all that is covered in the definition. If we are to be entitled to inspect a point at one end of a vector and associate it with conductor "*a*," and inspect the other end of the vector and associate it with conductor "*b*," then certainly we are entitled to inspect any of the infinite number of points that go to make up the whole straight line of the vector, and assign to those points a potential. This makes a potential gradient line out of the vector, and this is not justifiable by the definition.

W. K. SONNEMANN (M '43)
(Relay engineering section, Westinghouse Electric Corporation, Newark, N. J.)

To the Editor:

As a teacher of electrical engineering, I have been long aware of the chaotic condition in the literature regarding voltage conventions, and of the resulting confusion of students. The trouble, as the authors of the article, "Voltage Notation Conventions," point out, is not only the lack of a uniform convention but also of the failure of many authors even to state what convention they are using. Often writers employ single-subscript notation for voltages and mark the voltages on the circuit diagram by means of dimension lines, or arrows with heads at both ends, which certainly tell nothing concerning the assumed positive direction or polarity. Instead, the reader must deduce from the equations or vector diagrams what convention the author had in mind. I am glad that M. B. Reed and W. A. Lewis have brought this problem to the attention of the Institute with a view to eventual standardization. There is no reason why the conventions regarding voltage cannot be as definite as those regarding current.

I find myself in agreement with the main conclusions reached in the article; namely, that double subscripts on any voltage symbol (***E*** or ***V***) should indicate the assumed polarity in a uniform manner; that the first subscript should indicate the positive pole; and that on the circuit diagram the assumed polarity well can be indicated by a plus sign at one end of the dimension line which shows where the voltage is measured.

I find myself in disagreement, however, with some of the subsidiary statements and conclusions. The first of these is the allegation that voltage has polarity but not direction. Here, however, I agree with what I believe the authors mean but not with what they say. Just as a current which carries positive charge from *a* to *b* is said to have the direction from *a* to *b* and is denoted by $\boldsymbol{I}_{ab}$ so a potential drop or rise from *a* to *b* can be said to have the direction from *a* to *b* and can be denoted by $\boldsymbol{V}_{ab}$ or $\boldsymbol{E}_{ab}$. Convention should determine whether a drop or rise is meant, and the authors, for two good reasons, recommend that it be always the drop. The choice between the words direction and polarity might appear to be a mere quibbling. I believe, however, that what the authors have in mind is the direction of the voltage drop through a circuit element relative to the direction of current through the same element. These directions are the same in a load but are opposite in a source. The direction of voltage between two points cannot be related uniquely to the direction of current between the same two points, not because the voltage has two directions but because, as the authors have pointed out, the current has different directions in different circuit paths between the points.

Secondly, I want to defend the use of a

dimension line with an arrowhead at one end only as an alternative to the one with arrowheads at both ends and a plus sign at one end as a means of indicating the positive direction of a voltage in conjunction with single-subscript notation or, redundantly, with double-subscript notation. If $\boldsymbol{I}_{ab}$ is equivalent to $\boldsymbol{I}$ with an arrow pointing from a to b, why should not $\boldsymbol{V}_{ab}$ be equivalent to $\boldsymbol{V}$ with an arrow pointing from a to b? Or, to turn the matter around, if we indicate the polarity of a voltage by a plus sign at the point of higher potential, why not indicate the direction of a current by a plus sign at the end of the branch whre the current enters. (This is done on d-c ammeters.) In other words, why use one system for indicating direction of voltage and another for indicating direction of current? Should we indicate the direction of magnetic flux, magnetic potential, and electric flux by still other symbols? Possibly, we should denote magnetic potential by N and S. The simplest way, however, is to use arrows for all these quantities.

For consistency with the recommendations of the article, if voltage arrows are used they should point in the direction of voltage drop. (This is the opposite of what I have been doing, but I am willing to change.) Another reason for standardizing on voltage direction as the direction of *drop*, in addition to those given in the article, is that this direction agrees with the defined direction of electric field.

Thirdly, I disagree with the statement that "assigning a particular subscript to one end of a vector is a questionable practice." On the contrary, it is a very useful practice when applied to voltage vectors. It is always possible to draw a voltage vector diagram for an a-c circuit (with restriction to sine waves of one frequency) in such manner that for each point on the circuit there is a corresponding point on the vector diagram and that the vector joining any two points gives the phase and magnitude of the voltage between the two corresponding points of the circuit. Often this form of vector diagram is the most useful one. It is used widely for polyphase transformer connections; indeed, the connections are named (for example, Y, delta, T, V, zigzag) from this form of positive-sequence voltage diagram.

Figure 7*C* of the article is another vector diagram of this type. The origin might be labeled $a'=b'$; the head of the upper vector, a; the head of the lower vector, b, and the head of the middle vector, some symbol (say c) for the junction above the shunt branch. Then each vector points in the direction of voltage rise from the tail letter to the head letter, or of voltage drop from the head letter to the tail letter, which seems unnatural if drops are taken as standard.

A way to remedy this inconsistency is to rotate all current vectors in Figure 7 through 180 degrees with respect to the voltage vectors. The resulting diagram is entirely correct and in accord with the recommended convention that vectors represent voltage drops and yet we can label the end points of the voltage vectors so that each vector points from the first subscript to the second in the recommended double-subscript notation. The only disadvantage of such a diagram is its unfamiliar appearance. Even this disadvantage can be avoided by interchanging the order of subscripts on the currents and reversing the current arrows on the circuit diagram instead of reversing the current vectors. Thus the only disadvantage of convention IIA cited by the authors disappears, at least partially.

EDWARD W. KIMBARK (M '35)

(Professor of electrical engineering, Northwestern University, Evanston, Ill.)

Capacitance Effect

To the Editor:

Walther Richter's article on "Capacitance Effect of Conductor in Magnetic Field," (*EE, Aug '47, pp 784–6*) deals with the critical choice of symbols and units for force and mass. In my estimation, considerable confusion can arise from some of the choices he has made.

His statement that "calculations are made in the technical metric system, kilogram, meter, and second being the units for force, length, and time respectively" disturbs me greatly, in that I firmly believe that we must consider the kilogram as the unit of mass if we are to avoid inconsistencies completely.

One cannot divide the weight of the body in Richter's kilograms by 9.81 to obtain the mass of the body as his equation 11 states. If so, may I ask for the name of the unit one thus would obtain?

True, the kilogram is a convenient unit for specifying substance, but let us use the symbol M for it and not W.

Richter's difficulties become specific regarding rotating bodies with his statement involving power, which follows his equation 16. A meter-kilogram per second is *not* a proper unit for power. Rather the unit is a meter-newton per second. Properly then, equation 17 should read:

$$T\times\omega=E\times i$$

Likewise, either the 9.81 should be deleted from the denominator of equation 18, and the final equation 19 should read:

$$C=\frac{WR^2}{9.81\times\frac{E}{\omega}\times\frac{E}{\omega}}=\frac{WR^2\times\omega^2}{9.81\ E^2}$$

$$=\frac{WR^2\times4\pi^2\times n^2}{9.81\times60^2\times E^2}$$

where W is the weight of the rotor in newtons, or the W's of Richter's equation should be changed to M's.

Because Richter's constants c_1 and c_2 become identical when the 9.81 difficulty is eliminated, a simpler expression would be

$$C=\frac{WR^2}{9.81c^2}=\frac{MR^2}{c^2}=\frac{I}{c^2}$$

where

C = the capacitance in farads

I = the moment of inertia either in newton-meter-second^2 or in kilogram-meters^2

c = the machine constant either in volt-second per radian as in Richter's equation 15 or in newton-meter per ampere as in his equation 16, the two values being numerically equal

Richter's misinterpretation of dimensional units continues in his energy relationships in the *MKS* system. In these he states that energy is measured in meter-kilograms whereas it properly is measured in meter-newtons or joules. Thus, the 9.81 factor again is inserted erroneously by his statement that "1 meter-kilogram = 9.81 joules." Equation 20 should have read:

$$W=\frac{I}{2}\times\omega^2 \text{ newton-meters (or joules)}$$

and the equating of equations 20 and 21 then properly would have yielded

$$I\times\omega^2=\frac{WR^2}{9.81}\times\omega^2=C\times E^2$$

or

$$C=I\times\frac{\omega^2}{E^2}=\frac{WR^2}{9.81}\times\frac{\omega^2}{E^2}$$

The reference to Rüdenberg "Elektrische Schaltvorgänge," has been checked and if Richter will interpret Rüdenberg's G of equation 51, page 142, third edition, as mass (not weight as Richter's symbol W implies) he will have Rüdenberg's meaning as intended.

The difficulties caused by the various interpretations placed upon the English unit of a "pound" should be evidence enough that we never must start using the kilogram as a unit of force, else we shall be cursed forever after with the uncertainty of whether mass or force is meant. In the *MKS* system we have the newton as the proper unit of force. If we once begin to use the kilogram as a unit of force we are lost.

The illogic of any other approach is illustrated best by Richter's checks in the *MKS* and English systems. In the *MKS* system his use of W is for mass in kilograms. In his English system his W is for force in pounds and he must divide by 32.16 to obtain the correct result of his equation 22. Could anything be more illogical?

If we wish to avoid the use of newtons in specifying the weight of a body, then let us use M (G in Rüdenberg) or some other distinguishing symbol which will call attention to the fact that a unit of mass is required.

This letter is not written with a feeling of depreciation. The ideas of Richter's article are excellent. Such fundamental papers present new ideas to the membership and will be referred to many times. For this very reason we should be extremely careful that the material as published cannot be misinterpreted.

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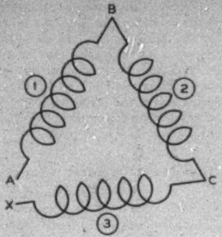
An Electrical Problem

To the Editor:

We wish to present a problem which we believe the readers of *ELECTRICAL ENGINEERING* will find interesting. The application of good theory seemingly leads to a falacious conclusion from an operating standpoint, however, the reader will be the judge.

Referring to Figure 1, consider the three coils shown as the secondaries of transformers the primaries of which are excited by 3-phase

Figure 1



voltages equal in magnitude and displaced by 120 electrical degrees. Further consider that phase rotation is *ABC* or $E_{ab}-E_{bc}-E_{cx}$ or to be more explicit let $E_{ab}=E_e^{j60}$, $E_{bc}=E_e^{-j60}$ and $E_{cx}=E_e^{j180}$. With the coils connected as shown equal voltage will be read between *AC* and *CX*, however, with the delta bank closed there will be no circulating current (neglecting consideration of harmonics). This then proves that coils *1* and *2* alone produce an equal and opposite voltage to that of coil *3* or $E_{ab}+E_{bc}=E_{ac}=E_e^{j0}$. Now omit coil *3* entirely and you have an open delta transformer bank the voltages of which are $E_{ab}-E_{bc}-E_{ac}$ whereas normal 3-phase voltage would be $E_{ab}-E_{bc}-E_{ca}$. Thus you have three voltages displaced by 60 degrees. Therefore, in conclusion an open delta transformer bank (*unloaded*) does not produce 3-phase (120 degrees displacement) voltages which are certainly necessary for operation.

We would be interested in receiving the readers' reactions to this problem.

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NEW BOOKS • • • • •

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING. By A. Gray, revised by G. A. Wallace. Sixth edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 568 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4.50. Written for the use of engineering students not specializing in electrical engineering, this text emphasizes and develops fundamental principles with a minimum of mathematics. Revisions have been made in the light of current standards and practice. New topics include the amplidyne, ignitron, fluorescent lamps, tetrodes and pentodes, the push-pull amplifier, electronic timer, and stroboscope.

RADIO ENGINEERING. (McGraw-Hill Electrical and Electronic Engineering Series.) By F. E. Terman. Third edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 969 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $7. Covering all phases of radio communication, this volume emphasizes fundamental principles and basic techniques rather than details of current practice and industrial equipment. Largely rewritten, this third edition incorporates the important changes of the past decade.

SCIENCE IN PROGRESS. (Society of the Sigma XI. Devoted to the Encouragement of Research in Science. National Lectureships 1945 and 1946.) Fifth series. By F. B. Jewett and others, edited by G. A. Baitsell. Yale University Press, New Haven, Conn., 1947. 353 pages, illustrations, diagrams, charts, maps, tables, $9^1/_2$ by 6 inches, cloth, $5. Beginning with a discussion of the future of scientific research in the postwar world, this fifth volume contains reports of recent major investigations in widely varied fields. The present knowledge of the earth's center, the development of the betatron, and a summation of the progress in catalysis research are considered. More than one-half of the book is devoted to various phases of biology.

STEAM AND GAS ENGINEERING. By T. E. Butterfield, B. H. Jennings, and A. W. Luce. Fourth edition. D. Van Nostrand Company, New York, N. Y., 1947. 588 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $6. This new edition follows the policy of the previous ones in giving the latest facts and best procedures in elementary steam and gas engineering. The considerable revision includes a shifting of the order of presentation of material for a more logical approach. The text provides a full treatment of heat power engineering for students taking only one heat-power course, or an introductory course for those specializing in the field.

TABLES OF SPHERICAL BESSEL FUNCTIONS. Prepared by the Mathematical Tables Project, National Bureau of Standards, volume 2. Columbia University Press, New York, N. Y., 1947. 328 pages, tables, $10^3/_4$ by $7^3/_4$ inches, cloth, $7.50. The major part of the present volume is devoted to tables of the spherical Bessel functions $\sqrt{\pi/2x}\;J_n(X)$, for $\pm n$ ranging from 29/2 to 61/2 with from 7 to 10 significant figures. This set of tables complements those previously published for $\pm n$ ranging from 1/2 to 27/2. Both volumes 1 and 2 contain interpolation methods and notes on their respective tables.

TECHNOLOGY OF INDUSTRIAL FIRE AND EXPLOSION HAZARDS. Two volumes. By R. C. Smart. Chapman and Hall, Ltd. London, England, 1947. Illustrations, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, volume 1, 202 pages; volume 2, 184 pages, 16s. each volume. The broad coverage of these two volumes should make them of interest in a wide field of industrial and insurance work. Fire wastage and research are dealt with in volume 1, as well as the thermal reactions of materials and fire risks with agricultural products, coal, industrial fuels, and gases. New materials, techniques, and processes are discussed in volume 2. Examples of actual fires and explosions are given throughout the book.

TELEGRAPH TRANSMISSION THEORY. By E. H. Jolley, with a foreword by F. E. Nancarrow. Sir Isaac Pitman and Sons, Ltd., London, England; Pitman Publishing Corporation, New York, N. Y., 1947. 124 pages, diagrams, charts, tables, $8^1/_2$ by $5^1/_2$ inches, stiff cardboard, 7s.6d. This small book treats its subject in a way suitable for the less advanced student, keeping the necessary mathematical knowledge at a minimum by using graphical examples to a large extent. The proofs of all formulas have been collected at the end of the book, allowing better continuity of the practical treatment which is emphasized throughout the book.

THEORY AND APPLICATIONS OF ELECTRICITY AND MAGNETISM. By C. A. Culver. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 594 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $5. Covering the phases of electricity and magnetism usually treated, this volume is intended as a basic text for those who will take advanced courses, in physics, chemistry, and electrical engineering. A knowledge of general college physics and integral and differential calculus is assumed. The electron theory of matter is followed.

WATERBURY'S VEST-POCKET HANDBOOK OF ENGINEERING. Fourth edition, revised by H. W. Reddick and others. John Wiley and Sons, New York, N. Y.; Chapman and Hall, Ltd., London, England, 1947. 386 pages, diagrams, tables, $5^1/_2$ by 3 inches, fabrikoid, $2.50. This practical pocketbook provides mathematical engineering data under the headings of algebra, trigonometry, mensuration, analytic geometry, differential and integral calculus, theoretical mechanics, mechanics of materials, fluid mechanics, heat engineering, and electrical engineering. New sections added in this edition cover illumination engineering and radio-electronics formulas.

YEARBOOK OF THE HEATING AND VENTILATING INDUSTRY. Published by Technitrade Journals Ltd., 8 Southampton Row, London, W.C. 1, England, 1947. 139 pages, diagrams, charts, tables, $8^3/_4$ by $5^1/_2$ inches, cloth, 5s. Providing technical, contractual, and other trade information, this volume is of interest to architects, engineers, and others who have contact with heating and ventilating contractors. Technical articles in this edition are on thermal insulation, district heating, technical education, and standardization.

VERY HIGH-FREQUENCY TECHNIQUES, two volumes. Compiled by the staff of the Radio Research Laboratory, Harvard University; H. J. Reich and others, editors. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 1,056 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $14. This 2-volume set presents those techniques, at frequencies above about 100 megacycles, that are of general interest and value and which were developed during the course of the work at the Radio Research Laboratory. The bibliography and the index for both volumes are included in volume 2.

BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS. 1946 supplement, prepared by committee *B-4* on electrical-heating, resistance, and related alloys of the American Society for Testing Materials, technical publication number *56-C*. 1916 Race Street, Philadelphia 3, Pa., 1947. 23 pages, 9 by 6 inches, paper 75 cents. Giving replacements and new references for 1940–44, this third supplement also covers publications in 1945 and 1946. Owing to the wide variety of problems involved in the successful functioning of contacts, a reasonable latitude has been allowed in subject matter. The items are listed chronologically with both subject and author indexes.

ELECTRICAL AND TECHNICAL CERAMIC INDUSTRY OF GERMANY. 74 pages, *PB* 18776. By R. Russell, Jr.; with supplement, "High Dielectric Constant Insulators," by B. S. Ellefson. 8 pages. Mapleton House, Publishers, 5415 Seventeenth Avenue, Brooklyn 4, N. Y., 1947. Diagrams, charts, tables, $7^3/_4$ by 5 inches, paper, $6. This volume is the report of the Joint Intelligence Objectives Agency on companies in Germany which manufactured ceramics. The phases of the industry, covered most extensively, include various types of electrical insulation, dielectrics, and technical ceramics for chemical and laboratory use, and special applications also are considered. Particular attention was directed to the field of special ceramics known as sintered refractory oxides.

L'ÉLECTROCHIMIE ET L'ÉLECTROMÉTALLURGIE. Two volumes. By A. Levasseur. Sixth edition review. Dunod, Éditeur, Paris, 1947. Volume 1, 175 pages; volume 2, 202 pages, diagrams, charts, tables, $9^3/_4$ by $6^1/_2$ inches, paper; volume 1, 280 frs.; vol. 2, 330 frs. Volume 1 of this 2-volume set discusses the various aspects of electrolytic theory, and also the general principles of electrochemical and electrometallurgical applications, such as the alkali and chlorine industries, copper refining, electrodeposition of metals. Volume 2 covers the various types of electric heating equipment, and the important uses of electric furnaces in the fields of metallurgy, foundry practice, calcium carbide, and nitrogen production.

ELECTROMAGNETISM. By J. C. Slater and N. H. Frank. McGraw-Gill Book Company, New York, N. Y., and London, England, 1947. 240 pages, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $3.50. Originating from the author's "Introduction to Theoretical Physics," this volume contains a more complete treatment of the foundations of electrostatics and magnetostatics and the new developments in the electromagnetic theory. Although the *m-k-s* system is used throughout, all important equations are developed in the Gaussian system in an appendix.

EXPOSITION, TECHNICAL AND POPULAR. Edited by J. R. Gould and S. P. Olmsted. Longmans, Green and Company, New York, N. Y., London, England, Toronto, Ontario, Canada, 1947. 126 pages, diagrams, tables, $8^1/_4$ by $5^1/_2$ inches, cloth, $1.75. Using the term "exposition" to mean the type of writing of which the basic function is to inform, this book describes writing techniques for the man with a technical background as well as for the general reader. The first section analyzes the various types of exposition, the research article is handled in section two, while the third section shows the devices which may be used in the adaptation of specialized material for the lay audience.

FLUORESCENT LIGHTING MANUAL. By C. L. Amick. Second edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. 318 pages, illustrations, diagrams, charts, tables, $9^1/_4$ by 6 inches, cloth, $4. The principles of operation and the design, construction, and performance characteristics of all types of fluorescent lamps are covered, providing manufacturers, contractors, dealers, and users with a reference manual for solving the various problems of modern fluorescent lighting practice. In this edition, material on new types and sizes of fluorescent lamps, auxiliary equipment improvements, recent lighting techniques, design data, and lighting comfort has been added.